Plummer's

A NEW METHOD OF CHEMISTRY;

INCLUDING THE

History, Theory, and Practice of the ART:

Translated from the ORIGINAL LATIN of

Dr. *BOERHAAVE*'s

ELEMENTA CHEMIÆ,

AS PUBLISHED BY HIMSELF.

To which are added,

NOTES; and an APPENDIX,

SHEWING

The NECESSITY and UTILITY of Enlarging the Bounds of CHEMISTRY.

WITH SCULPTURES.

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THE THIRD EDITION, corrected.

VOL. II.

LONDON:

Printed for T. and T. LONGMAN, at the *Ship* in *Pater-Noster-Row*.

M.DCC.LIII.

THE
ELEMENTS
OF
CHEMISTRY.

PART III.

Containing the PROCESSES or OPERATIONS of the ART.

PRELIMINARIES.

Rules to be observed in conducting a course of chemical processes.

1. NOTHING has more disgusted the Intelligent, in turning over the writings of the Chemists, than those numerous indigested experiments, delivered under the title of *processes (a)*. For these processes are found to be so many, and so different, that the life of a man is scarce sufficient to go through them all, nor any patience equal to the fatigue. But the greatest obstacle has been, that men do not perceive to what end all these labours tend. For were a philosopher to consult the artists themselves upon the subject, he would hardly receive a satisfactory answer. And after chemistry began to be taught in the universities, the writers of *chemical institutions* aimed at little more than delivering certain examples in a promiscuous manner. When, therefore, thirty years ago, at the request of my pupils, I undertook the teaching of chemistry; I seriously considered how to give publick examples of the chemical operations, in an elegant order, after the *Hippocratical* manner, so that nothing might be done without care and design.

2. The first thing to be here solicitously regarded, is to do nothing in vain; for what is more unnecessary, than to repeat ten times over, by other examples, what is sufficiently exhibited by one? When I have once shewn

(*a*) Chemical operations, or *processes*, are particular methods of changing the bodies described in the foregoing theory, by means of the instruments there enumerated; so as to render the changes observable to the senses. Or more peculiarly, a chemical process is such an application of fire to any subject, as may effect a sensible change therein; yet leave the subject capable of being compared with what it was before.

how the fragrant water is procurable from baulm, there is no occaſion nauſeouſly to repeat the ſame thing, by a freſh example in marjoram, roſemary, and rue. Why ſhould a perſon inſtructed to obtain the aromatic ſpirit of citron-peel, be laboriouſly taught to do the ſame thing in numerous other ſubjects (*a*)?

3. 'Tis however neceſſary that the learner be ſhewn a plain example of every operation, which contains any thing ſingular, of ſervice in the art, and is not elſe exhibited by any other experiment: For the ſtudent in chemiſtry ſhould at leaſt underſtand the principal ways of procuring the uſeful things. And it would be wrong in this art to leave any one unacquainted with the uſeful methods of working. But to what purpoſe ſhould a perſon deſirous of knowing the nature of ſalts in vegetables, ſee the method of extracting them from their aſhes, unleſs he alſo learns how diſtillation and putrefaction may obtain, and produce them from certain plants?

4. Next, I conſidered, that the order to be obſerved in exhibiting theſe proceſſes, ſhould be the order of the mathematicians, and the experiment that was firſt made, be required to the artificial performance, or juſt underſtanding of the following (*b*). I alſo preſumed there ſhould be a relation between them; ſo that the ſubſequent might proceed directly and immediately from the antecedent: By which means, in a ſhort time, with little labour, and leſs expence, nearly the principal uſe of the whole art might be learned; which uſe is highly excellent, as that whereby we underſtand the powers of nature, and the inſtruments of health.

5. Laſtly, in the conduct of theſe proceſſes I would not have an eye wholly to medicine; tho' I otherwiſe prefer this to other arts: no greater fatality hath befaln either chemiſtry or medicine, than that weak opinion, as if all chemical preparations were conſtantly proper inſtruments in phyſic. Whereas it is plain, that chemiſtry by no means adminiſters to medicine alone, but to univerſal phyſics (*c*). Let pharmacy enjoy the operations of chemiſtry, but by no means claim them all to itſelf. Since therefore the operations of chemiſtry are performed upon vegetables, animals and minerals, we ſhall range our operations with regard to theſe three tribes of bodies.

To begin with vegetables. 6. We are obliged to begin with vegetables, becauſe theſe every where ſpontaneouſly offer themſelves; and becauſe moſt animals are compoſed of vegetables taken as aliment, and converted into their own ſubſtance. And tho' ſome animals may wholly feed upon others, yet at length they all derive their nouriſhment and the matter of their bodies from vegetables; which alſo undergo a chemical reſolution with greater eaſe, on account of the greater ſimplicity of their parts, and therefore may be the better underſtood. Minerals indeed are ſtill more ſimple; but then their treatment requires more

(*a*) Perhaps by carefully obſerving this rule, a conſiderable number of the following proceſſes might be dropt as uſeleſs in this view. See for inſtance proceſs 6, 8, 10, 12, 16, 17, 19, 22, 24, 25, 26, 27, 28, 29, 30, 31, 41, 44, 46, 54, 57, 58, 59, 60, 61, 63, 69, 70, 71, 72, 80, 82, 83, 84, 85, &c. &c. which may intimate a ſerviceable abridgment of the pure *elementary part of chemiſtry*.

(*b*) This muſt not be underſtood in a ſtrict mathematical ſenſe.

(*c*) See the uſes of chemiſtry in *the theory*.

ſecret

ſecret arts, leſs known inſtruments, and leſs obvious operations. Whence the law of method directs us to begin with vegetables.

7. To proceed the more regularly, we ſhall take for granted what is delivered in the theory upon the ſubject of vegetables (*a*): All which we are now proceeding to confirm by experiment.

8. A *chemical operation* we define the change of a body by the inſtruments of this art, to an end preſcribed by the laws of the art.

9. The firſt operation to be performed in a courſe of chemiſtry ſhould have theſe four conditions: *Firſt*, It ſhould be very eaſy, ſo as not to require any great phyſical labour; whereby a violent corporeal force is applied to the ſubject. *Secondly*, It ſhould be ſimple, or not compounded of various concurrent operations; nor require a variety of inſtruments. *Thirdly*, The change it makes ſhould not be very remote from the nature of the ſubject. *Fourthly*, The effect produced ſhould rather conſiſt in a ſeparation of the parts, ſuch as they were originally, than be changed by the operation: for as bodies, by this art, are reſolved either into their natural parts, or parts acquired in the operation, it is plain that the firſt alone ſhould here be obtained; ſo that by re-adjuſting the ſame parts, we may be certain of producing the original ſubject again. *Conditions of the firſt operation.*

10. By duly obſerving theſe four requiſites in our firſt operation, we ſhall receive four great advantages. For, *firſt*, the artiſt will hence clearly perceive what thoſe parts were, as they originally exiſted in the ſubject; and thence form a true judgment of its nature, and the diſpoſition of its component parts. And without this procedure we might commit great errors, by imagining that the parts were ſuch in the whole as they appear after the reſolution. *Secondly*, We ſhall thus diſcover the nature of the remains, or what is left of the ſubject after it has been treated: for if only a gentle ſeparation be made of the native parts, the remainder will appear but little altered. *Thirdly*, We ſhall hence be able to examine this remainder by a new operation: and thus by degrees every ſubject may be properly examined by all the art of chemiſtry. But under a different procedure, if a new operation was to be performed upon a ſubject greatly altered, little juſt knowledge could be acquired, and the ſcience would rather be confounded than illuſtrated. In the *fourth* place, we ſhall hence obtain an exact knowledge both of the action employed in the experiment, and of the inſtruments employed to procure it; and what great advantages theſe are in chemiſtry is ſelf-evident. I wiſh I could have found an author who had delivered his experiments in this method.

11. The laws of chemiſtry alſo require particular conditions in the ſubject of this primary operation: the firſt whereof is, that the part ſeparated be the moſt ſimple of thoſe afforded by any operation, ſo as to be uniform, like water. Secondly, that it be what enters the compoſition of other bodies, and not itſelf produced from them. Thirdly, that it be eaſily ſeparable into thoſe parts deſigned to be obtained from it: otherwiſe it might happen that a ſimple and tractable body might be very difficult to ſeparate into its conſtituent parts; which is evidently the caſe in gold, quickſilver, and ſilver. The prin- *Conditions of the firſt ſubject.*

(*a*) See the article vegetables in the *theory*.

cipal uſe of theſe conditions in our firſt ſubject is, that thus we may obſerve the natural order in our firſt production; and, at the ſame time, leave the remainder fit to have its other parts diſtinctly ſeparated by new operations.

Conditions of the firſt inſtrument.

12. Again, the inſtrument of this firſt operation alſo requires its conditions; and muſt in the firſt place be ſimple, that the changing power excited by its means may be eaſy to underſtand and apply; and alſo not foul the ſubject by the admixture of its own parts, which are often of a different nature.

13. Secondly, the action of this inſtrument muſt be ſuch as is required in the ſubſequent operations; and therefore in this reſpect may be called univerſal, as its action muſt contribute in all the other operations; ſo that whilſt other inſtruments act, this alſo muſt be concerned.

14. Thirdly, this inſtrument muſt occaſion but little change in the ſubject, or no greater than may barely ſuffice for performing the firſt operation; otherwiſe the operation would be confuſed.

15. Fourthly, this inſtrument muſt not produce much diſturbance in the different parts of the ſubject; for if theſe ſhould be greatly diſordered, or changed, by mixing confuſedly among one another, the action of ſuch an inſtrument would rather prejudice, than promote natural knowledge. When an inſtrument thus conditioned, applies its particular action to ſuch a ſubject as above deſcribed, the artiſt will have an exact knowledge of the power of this primary action, and underſtand what will happen in the ſubſequent operation, ſo far as the efficacy of that firſt action is here concerned; and all theſe effects will therefore be clear, diſtinct, previouſly requiſite to be known, and ſubſervient to others. In particular, we ſhall hence evidently diſtinguiſh all the parts that naturally contributed to compoſe the ſubject.

16. It follows from the premiſes, that ſuch a gentle action of fire, as is always preſent on our globe, being applied to the fluid and moſt moveable parts of a vegetable ſubject, ſo as to cauſe little alteration, but a gentle ſeparation, will perform our firſt operation.

The ſtructure of vegetables.

17. All vegetables conſiſt of ſolid and fluid parts: the ſolid parts are either veſſels, or conſiſtent groſs parts made up of veſſels. (1°.) The abſorbing veſſels of plants drink in the fluid moiſture that touches them; the mouths of theſe veſſels are ſpread over the whole ſurface of the plant, and all its parts, eſpecially the root; they are dilated in a moiſt and hot air, and in the dewy and warm earth, but cloſed when it is cold and dry. Whence they open wider under ground, than in the air; and drink more in the ſummer, than in autumn, and the winter. Certain orifices alſo draw in the air like wind-pipes, and convey it deep into the body of the plant; as evidently appears in the blown *taraxacum.*

18. (2°.) There is another ſet of moving veſſels in plants, which, being hollow, contain the juices drank in by the abſorbent kind. Theſe move from the ſurface through all the parts of the plant. This motion ſeems chiefly owing to the dilatation of heat, and contraction of cold: whence the veſſels ſcarce ever reſt long, but conſtantly contract and dilate by turns; the elaſtic fibres of the veſſels thus continually propelling the juices. No valves have hitherto been here manifeſt to the ſenſes; and the experiment of trees growing when inverted ſeems to ſhew there are none.

(3°.) Plants

(3°.) Plants have alfo veffels that change the juices imbibed into others of different kinds and forms; for the juices received at the mouths of the veffels are very different from thofe which have paffed thro' the veffels of the plant; and they gradually more affume the nature of each plant, the longer they have felt the force of more of its veffels; as we find confirmed by all kinds of experiments. There feem alfo to be certain fets of veffels proceeding from others, and conftantly elaborating different kinds of juices in every plant.

(4°.) Among thefe veffels, there are fome that, rifing laterally from thefe larger changing kind, thence receive a particular juice, which they again change by degrees into that of their own kind. Thus in the aloes-plant there are certain canals which carry a bitter juice, very different from thofe contained in the other veffels, and prepared in the fame plant. Such particular veffels we alfo find in the greater celandine, where the eye may difcern a yellow juice, made by fecretion and farther change; as a milky one is found in the peculiar veffels of the fpurge.

(5°.) There are alfo peculiar receptacles in plants, where thofe particular juices are received, and long remain at reft, which were feparated by the fourth kind of veffels, tho' thefe juices feem to be there farther elaborated and changed. Thus we plainly difcover a fat fubftance collected, contained, and perfected in certain cavities; whilft it there paffes through different, and often various kinds of forms; as we fee in native oils, balfams, and rofins.

(6°.) Plants alfo have excretory ducts which difcharge the finer juices from their bodies; or elfe their veffels being burft by an encreafe of quantity, thus let them efcape. Every one knows that invifible exhalations breathe from plants; and that gums and rofins fweat from their broken cells. Thefe feveral kinds of veffels contain each its peculiar fluid, diftinguifhable in every refpect from all the reft; not only in confiftence, acrimony, or foftnefs, but alfo in colour, fmell, tafte, medicinal, nutrimental and poifonous properties: and the like diverfity is found in the different parts of plants, even the remoteft. We have a fweet liquor in the bottom cavity of the aloes-flower, tho' the juices in the other parts are bitter: and different kinds of juices are found in the root, flower, fruit, feed, leaves, bark and wood of vegetables. Again, the different native juices of plants are themfelves compofed of very different kinds of principles, which, by particular combinations of certain parts, conftitute thofe juices: whence they again appear different, on account of the different proportions wherein thefe principles contribute to their compofition. Hence we have juices that are aqueous, fpirituous, faline, faponaceous, gummous, oleaginous, balfamic, refinous, gummo-refinous, and fuch as fweat in the form of tears, either from an incifion made in their bark, or tender twigs; which thus diftil a juice in the form of a limpid and tartifh water; as we evidently fee in the vine, the birch, the walnut, and many other trees.

19. It was neceffary to premife thus much before we enter upon our firft operation, in order to underftand what found, diftinct, and juft knowledge the art of chemiftry may afford us in vegetables; and at the fame time what confufion would proceed from an ill concerted opera-

tion.

tion. We now proceed to draw some corollaries from what is above delivered.

Corollaries from the preceding doctrine of VEGETABLES.

Their natures, with regard to chemistry. *Coroll.* 1. 20. HENCE it appears that there is a great diversity in the juices of vegetables, to be observed with regard to chemistry; since some of their parts are readily moveable, and easily separable from the rest; sometimes even spontaneously; so that a gentle heat may almost obtain them pure; whilst others of their parts separate with greater difficulty, and require a stronger heat, and hence come to be obtained more mixed and confounded among one another: and the due consideration hereof is of great importance.

Coroll. 2. 21. Since so many different juices are found in the different parts of the same plant, there must of necessity be a great difference in the chemical operations, according to the different parts whereon they are performed. Thus, the pulp of *cassia fistularis*, chemically treated, must needs afford a very different production from the bark or cane. And thus the pith of the *sugar-cane* affords a sweet or saccharine substance; and the other part of the plant an acid one. Let no one, therefore, inconsiderately say, he has chemically extracted this or that substance from a plant, without carefully relating what part of the plant he worked upon.

Coroll. 3. 22. There is another considerable diversity to be observed in respect of the colour of different vegetables, and their separate parts; as appears in apples, pears, cherries, strawberries, mulberries, and other fruit; and again, in a beautiful variety of leaves and flowers, which directs us to different ways of treatment. Thus, upon pricking the *spurge* or poppy, they weep an extremely white milk; but when bruised altogether, afford a dusky green coloured juice; whilst beet-root, on the other hand, yields an exceeding red juice when bruised, but when wounded one of a different colour.

Coroll. 4. 23. Again, we learn there is an extreme difference in the odours of the different parts of vegetables. Thus, no part of the jasmin is odoriferous but the flowers; whereas in the citron, the juice of the fruit, the rind, the leaf, the flower, the wood, have several and different scents. The different juices of the same plant seem each to obtain a different odour, according as the situation of their respective seats and vessels is farther removed from the pores of the absorbing surface. And this should be the more carefully observed, because the odours of plants greatly contribute to the distinguishing one plant from another, and are chiefly procured separate by the first operation in chemistry.

Coroll. 5. 24. We next observe, that different vegetables have also a variety of tastes; and to such degree, that among so many thousands of plants of different forms, there are scarce two to be said of the same taste; each of them having one peculiar to itself. Nor does this hold only of different plants, but also of the same individual, with respect to its different parts. And the same is to be understood, in the same sense, of colour and odour.

25. 'Tis

25. 'Tis likewise manifest that the juices of the same plant are so different at different times, as scarce to appear of the same kind, either in respect of colour, taste or odour. And for particular virtues, no comparison can be made betwixt juices crude and mature. For from the spring, thro' the whole course of summer, to the end of autumn, vegetables are so different, at different times, as scarce to appear the same; at least they differ extremely in the four seasons. For, showers excite fragrant exhalations in plants, that in a dry time seemed faded; and to this head belong those differences that arise from the difference of the soil: thus the plants that grow in mountainous places differ extremely from those produced in a low wet soil. *Coroll.* 6.

26. The preceding doctrine also informs us, that nearly all plants in their first rising and growth abound with thin, watry, saline juices; and at this time contain a large proportion of salt: but that, after having felt the summer's sun, they become less watry, spirituous and saline; and chiefly abound with oil: whence the same operation will necessarily procure quite different substances from the same plants at different seasons. *Coroll.* 7.

27. Lastly, it is certain, that *chemistry*, tho' ever so exactly pursued, can scarce preserve the pure and perfect virtues of vegetables; as always mixing the parts first separated, along with those that succeed, and thus changing their extremely mutable nature, and introducing not only new forms, but properties. Chemical operations, therefore, are far from always separating the noble virtues naturally residing in some plants; but rather frequently alter them in a great degree, and sometimes turn them into the direct contraries; as appears to have been well understood by *Helmont* (a), when he expresly declares him "*happy, who could with safety and expedition cure diseases by means of crude simples*; this being the ancient method of cure, and recommended in *scripture*. For the *specific essence* is altered by fire: whence *extracts and magisteries* are frequently exhausted preparations: so great and lurking a thing is fire." And this admonition should be carefully remembred. On the other hand, it's certain that chemistry, by exquisite labour, does sometimes produce new bodies, that before had no existence in nature; and possessed of virtues otherwise unknown to nature; whence *art* by this means effects, what in the natural state of things were impossible, according to the just observation of *Helmont* in the same place. *Coroll.* 8.

28. Thus much was necessary by way of introduction to our *processes upon vegetables*. If we should seem too tedious in our preparation, the caution we use must be an apology; for, one physical operation rightly performed, and free from error, will conduct to a thousand others that are to follow; but a single error in a *physical experiment* might occasion thousands.

29. We shall now proceed to our processes; and, always first examine by our senses the body we design to change, that it may be the better understood in its own nature, before it undergoes any alteration. In the next place, I will exactly describe the operation itself; whereby the subject, before examined, is to be treated; so that the causes which produce the effect may be understood. Thirdly, I will enumerate the effects produced in the subject by the operation. *The method to be observed in the processes.*

(a) Pag. 141. §. 45. pag. 458, 459.

ration. Fourthly, we will again examine the remainder, and compare it with what it was before; in order to learn the obfervable changes wrought upon it. Fifthly, I will endeavour to defcribe the feveral inftruments employed in every operation. Sixthly, I will fubjoin the phyfical corollaries, which fpontaneoufly flow from the operation performed. Seventhly, I will add the medicinal virtues of the produce; with care to mention only fuch as may be verified by experience; avoiding all exaggeration: I will alfo declare the infignificancy of many others, and mark the pernicious properties of fome, which are often unjuftly commended. And herein I judge I may be of fervice; as long experience, in chemical and medicinal affairs, has enabled me to perform this part; and as I have here no reafon to deceive.

30. I will begin with a recent native vegetable that has hitherto undergone no change; and fhall firft draw from it all that would rife by the heat of the fummer's fun; that is a very volatile and confiderably fimple water. As much as poffible, I will perform all the experiments upon one, and the fame vegetable; that we may thus precifely learn what effects different operations, conducted by the rules of art, and thus fucceffively applied, will have upon the fame plant. And after having fhewn all the chemical ways of drawing a fragrant water from recent rofemary, I fhall regularly proceed to fhew how the falts, oils, and other things are to be obtained from the fame plant; and this fo long as poffible: for thus we fhall have a diftinct and accurate knowledge of the chemical operations. Whereas, if we obtained the water from one plant, the falt from another, and oil from a third, the fermented fpirit from a fourth, and the volatile falt, by putrefaction, from a fifth; we could neither rightly underftand the analyfis of the plant by the operations, nor the true action of the operations upon the plant; but all would appear confufed. Thefe preliminaries were neceffary, before we came to the operations themfelves; which we fhall now begin.

PART

PART I.

Chemical Operations upon VEGETABLES.

PROCESS I.

The diſtilled water of roſemary, extracted in the form of vapour, by the heat of the ſummer's ſun.

' 1. TAKE roſemary freſh gathered, in its perfection, with the morning ' dew upon it, and, 2. lay it lightly and unbruiſed upon the broad ' round plate within our little cylindrical furnace (*a*); the plate being firſt ' made clean, and fixed at the height of two or three inches (*b*). Then ' cover the furnace with its large conical ſtill-head, and apply a glaſs re- ' ceiver to the noſe thereof. 3. In the fire-place of the furnace put a lighted ' coal (*c*), that does not ſmoke, and raiſe up an equable degree of heat, not ' exceeding 85 degrees on *Fahrenheit*'s *thermometer* (*d*); and let this heat be ' kept up ſo long as any liquor comes over. Then taking away the plant, ' put in freſh and proceed as before; continuing to do this ſucceſſively till ' a ſufficient quantity of the water be procured. 4. Let this diſtilled liquor ' be kept at reſt, in a clean glaſs cloſe ſtopped, for ſome days, in a cold ' place, whereby it will become limpid, and have the taſte and odour of ' the plant.'

The nature and uſe of this water.

1. In this water are contained, (1.) the liquor of dew, conſiſting of its own proper parts (*e*), which are difficultly ſeparated from the plant; and cleave to it even in the drying. This dew, alſo, by ſticking to the outſide, receives the liquid parts of the plant, which being elaborated the day before, and exhaling in the night, are hereby detained; ſo that they concrete together into one external liquid, which is often viſcid, as appears in wax, manna, honey, &c. (2.) This water alſo contains the fluid which exhales from

(*a*) Deſcribed, tab. xvii. fig. 2.

(*b*) Above the grate, ſuppoſe, or plate which ſupports the fire.

(*c*) This coal ſeems to be meant of *Dutch* turf, which, when once thoroughly ignited, yields no groſs ſmoke, but makes a laſting fuel, and will of itſelf entirely burn out, tho' buried in aſhes.

(*d*) See the theory.

(*e*) See the theory.

the veſſels of the roſemary, and which chiefly conſiſts of ſimple water, as appears upon long ſtanding in an open veſſel; when the taſte and odour vaniſhing, leave an inſipid water behind. Another part of this water is that ſubtile, volatile ſubſtance, which gives the plant its peculiar taſte and odour; for theſe the ſenſes diſcover in it: but the remains of the proceſs ſcarce afford any thing thereof. (3.) This ſame water ſeems alſo to contain ſeeds, or other little bodies; which in a certain time uſually grow into a kind of thin whitiſh weed, ſuſpended in the middle of the water; and daily encreaſing, or ſpreading itſelf, becomes a mucilage, which did not appear at firſt.

2. I have kept theſe waters undiſturbed in ſeparate well-cloſed veſſels, and obſerved, that in a year's time they began to appear thick; which thickneſs gradually encreaſed every year, till at length the whole liquor grew ropy or mucilaginous. Hence this water contains the elementary water, and preſiding ſpirit of the plant, a ſpirit ſmall in bulk but rich in virtue, and exhibiting the ſpecific ſmell and taſte of the ſubject. This water, therefore, in exhaling proves a vehicle to that ſpirit which contains in a ſmall, ſubtile, extremely volatile, and thence eaſily ſeparable ſubſtance, the particular virtue of the plant; leaving the remainder exhauſted in this reſpect: and hence proceeds the medicinal virtue of theſe waters, which principally depends upon their native ſpirit. For this ſpirit, having a briſk mobility in moſt plants, affects the nerves, and raiſes the ſpirits in caſe of their depreſſion. But beſides this common principle of action, plants have another peculiarly appropriated to each, and of wonderful efficacy: this in the language of *Paracelſus* is called their appropriated eſſence.

3. The odoriferous ſcents both of lavender, and of baulm, agree in this; that they excite the languid nerves: but the ſmell of lavender, beſides this, has another particular virtue, and ſo has baulm. From this virtue of plants proceed wonderful effects in the body; which can only be learnt from a faithful hiſtory of plants; where their virtues founded upon experience are delivered. This peculiar virtue has often a contrary effect to the common: the *Indian* hyacinth has an extremely fragrant odour; but excites ſtrange ſpaſms in hypochondriacal men, and hyſterical women. Rue alſo diffuſes a very ſtrong ſcent, which cures the ſpaſms occaſioned by the former odour.

4. We muſt alſo obſerve, that human induſtry has diſcovered, that this fine vapour of plants is productive of thoſe ſtrange effects occaſioned by vegetable concretes, as well in the way of evacuants, as alteratives; becauſe if this alone be totally ſeparated from medicinal or poiſonous plants, the remainder, tho' without almoſt any ſenſible loſs of weight, loſes all that efficacy. Hence a chemiſt ſhould be cautious and reſerved in aſſigning the virtues of theſe waters, and learn for ſome time before he pronounces with certainty. From theſe obſervations we may ſay, that theſe waters will frequently cure fainting, and prove agreeable in the way of perfume; for nothing more directly proves more refreſhing, and enlivening to the brain and ſpirits, than ſuch a water of baulm or rue; each of them full of the reſpective ſpirit of the plants.

5. If

5. If the veſſel be cloſe ſtopped, and ſet in a cool place, theſe waters will retain their virtues for a year; but if negligently kept, or any crack ſhould happen in the glaſs, their extremely volatile ſpirit ſecretly flies off, and leaves the water vapid. Our experiment alſo ſhews us, what it is which plants loſe by being dried in the ſummer's ſun; *viz.* the water, and the ſpirit we have been deſcribing. Hence alſo we know the nature of that fluid, which firſt riſes from plants in diſtillation; and what that matter properly is in plants, which gives their peculiar odour, *viz.* their preſiding ſpirit. Laſtly, we hence learn, in ſome meaſure, what thoſe effluvia are, which, principally, in the ſummer ſeaſon, and the open air, exhale from vegetables; for it is highly probable that theſe conſtant exhalations of plants, eſpecially in the day time, have a great agreement in their peculiar nature with the liquor produced in our preſent proceſs, tho' differing in this; that the exhalation is made from parts continually recruited by the root; whilſt in our experiment thoſe parts alone are collected, which are driven off from the plants, after being gathered, and no longer ſupplied with freſh nouriſhment. Whence the diligent and ingenious Dr. *Hales* obſerves in his *Vegetable Staticks*, that the diſtillation of the juice received in glaſs-veſſels, artificially applied to recent inciſions of plants, in the ſummer ſeaſon, is of a different kind (*a*) from common diſtillation.

6. Hence we may underſtand that the various, peculiar, and often ſurprizing virtues of plants, may be widely diffuſed thro' the air, and carried to a vaſt diſtance by the winds. So that we muſt not preſently account as fables what we find related in the hiſtory of plants, concerning the ſurpriſing effects of effluvia. The ſhade of the walnut gives the head-ach, and makes the body coſtive: The effluvia of the poppy procure ſleep: The vapour of the yew tree is reputed mortal to thoſe who ſleep under it: and the ſmell of bean bloſſoms, if long continued, diſorders the ſenſes. The ſtrong action of the ſun upon plants certainly raiſes atmoſpheres of great efficacy, by means of the ſpirits it diffuſes; and the motions of the winds carry them to a great diſtance. The dark ſhades of thick woods, where vapours are contracted, occaſion various diſeaſes, and often death to thoſe who reſide among them; as appears by melancholy examples in *America*, which abounds with poiſonous trees. For this ſpirit of plants is a thing peculiar to each ſpecies, abſolutely inimitable, nor producible by art. It has therefore virtues peculiar to itſelf, but ſuch as are ſtrangely agreeable to the human ſpirits. But becauſe the ſpirits of ſome plants are very manifeſt to the ſenſes, whilſt thoſe of others ſcarce affect our organs of ſmell and taſte by any ſenſible action, the chemiſts have chiefly deſtined to this firſt proceſs, thoſe plants which are remarkable for their grateful odour: ſuch as theſe of the following ſhort catalogue, for example, taken from the *European* officinals, and a few of the *Indian*.

(*a*) See Dr. *Hales*'s Vegetable Staticks, pag. 50.

Plants.

—Angelica.
—Anife.
—Bafil.
—Baulm.
—Bays.
—The Calamints.
—Calamus aromaticus.
—Camomile.
—Caraway.
—Cardamon.
—Caffia aromatica.
—Catmint.
—Celeri.
—Chervil.
—Cinnamon.
—Citron.
—Clary.
—Clove July flowers.
—Coriander.
—Creffes.
—Cumin.
—Dill.
—Dittany.
—Fennel.
—Feverfew.
—Galangal.
—The Garlicks.
—Heart-wort.
—Hyffop.
—Jafmin.
—Lavender.
—Leeks.
—Lemmons.
—Lily of the valley.
—Lily, white.
—Lovage.
—Mace.
—Marjoram.
—Marum.
—Mafterwort.
—Maftichina.
—The Maudlin-tanfeys.
—Melilot.
—Mint.
—Motherwort.

Plants.

—Nutmeg.
—The Onions.
—Orange.
—Origanum.
—Philadelphus.
—Polium.
—Rofes.
—Saffron.
—Sage.
—Savory.
—Scurvy-grafs.
—The Southern-woods.
—Spignel.
—Tanfey.
—Tuberofe.
—Valerian.
—Victorialis.
—Violet.
—Walnut.
—Wild-thyme.

Trees.

—Bay.
—Benjamin.
—Box.
—Cedar.
—Citron.
—Elder.
—Fir.
—Guaiacum.
—Juniper.
—Lemmon.
—Lime.
—Mastick.
—Myrtle.
—Orange.
—Peach.
—Pine.
—Rofe.
—Saffafras.
—Savin.
—Storax.
—Thuya, or Life-tree.
—Walnut.

7. Several

7. Several of thefe trees contain, in their different parts, an aromatic volatile matter, which may be obtained in this firft operation; for fometimes their peculiar virtue refides in the root; as the camphorated balfam in the cinnamon root; or in the wood, as in the *Rhodium* wood; in the bark, as in cinnamon; in the hufk, as in Walnuts; and frequently in the flowers, leaves, and feeds: Again, in the waters that diftil from them, as in the walnut; in their balfams, gums, tears, and rofins, as in the balfamic trees. And fo many things we learn from this firft fingle experiment; more might be added, but perhaps more would be tedious.

PROCESS II.

The infufion and decoction from the remainder of the firft procefs.

OUR fecond operation fhould be fo directed, and performed, as perfectly to obferve all the laws laid down by the firft; for thus again we fhall reap all the advantages that were there enumerated.

As therefore a dry heat of 85 degrees there performed its effect; it appears what action the fire and air in that degree have upon a plant. In this fecond we fhall examine what fire and water, gradually raifed from 85 degrees of heat to 212, or to the degree of ebullition may have; for water heated to 85 degrees throws off from a plant the water of our firft procefs.

'1. Take the remains of the rofemary in our firft procefs, which have now loft their verdure, plumpnefs, and fucculency, and are become brown, contracted, fhrivelled, lighter, and almoft without the natural fmell, and of a tafte fomewhat foreign from that of rofemary. The whole is now brittle, which before was fupple, foft, and vifcous: All which may appear by comparing this remainder with the recent plant. Inftead hereof we may take a plant gently dried, but not too long, in the open air of a fhady place, or even what is frefh gathered; for this will make no confiderable difference, becaufe the water of our firft procefs is always loft in the boiling.

'2. To the fubject, put into a clean veffel, pour pure clean rain water, heated from 85 degrees to the degree immediately under ebullition, viz. that of 211. Let the whole plant be well covered with the water; which muft now ftand together, in a clofe veffel, in this degree of conftant heat for the fpace of half an hour, or more. Then pour off the liquor, which will now appear brown coloured, and have but little odour, being deprived of the tafte of the rofemary found in the water of our firft procefs. This is called the infufion of rofemary, and contains the virtue of the plant but little altered. If the water of the firft procefs be mixed with it, it will advantageoufly contain the peculiar virtue of the plant for medicinal ufes. And perhaps this is the beft manner of conveying the medicinal virtues of herbs into the body, unlefs it be in the form of expreft juices.

'3. If the plant be boiled for fome minutes with water, the liquor then poured off is called a decoction, or apozem. If this be made in an open veffel, all the water of the firft procefs is loft, befides much other matter,

'as we ſhall ſee hereafter (*a*). If the operation be here performed in a very 'tall chemical veſſel, fitted with a ſtill-head and a receiver, and the water 'that comes over be afterwards added to the decoction, the whole will then 'have the principal medicinal virtue of the plant. And if the operation be 'performed in *Papin*'s digeſter, the decoction will then have the united vir-'tues of the plant, without any loſs of the ſpirit, or water of the firſt proceſs. 'But the peculiar virtue of the plant is here changed, as appears both by 'the ſmell and taſte, and in ſome degree by the effect; and it is extremely 'difficult in all theſe caſes to preſerve the odour, taſte and colour perfect.

'4. Upon the remains of the firſt decoction, pour boiling freſh water, 'make it conſtantly boil, then pour off the decoction, and carefully take off 'with a clean ſpoon all the froth that riſes in the boiling, ſetting it apart in 'a clean veſſel. This matter is unctuous, and, when gently dried, burns 'in the fire. Continue to pour on freſh water, pour off the decoction, and 'collect the froth, with care to avoid the admixture of any foreign matter, 'as ſoot, ſmoke, or the like; till the water at laſt poured on, comes off 'after a long continued boiling, as pure, taſteleſs, and colourleſs, as it was 'when put on; which will happen about the 20th repetition. After this 'it will be ſurprizing to obſerve the leaves of the roſemary remaining 'entire, turgid with water, of their original form and ſize; but having 'exchanged their green colour for a brown, and being ſunk to the bottom 'of the water wherein they floated before.'

5. The denſer the plant is, and the more reſinous, the more oily froth is thrown to its ſurface; and the leſs of that reſinous, or oleaginous virtue communicated to the water, becauſe not diſſolved therein; and therefore for preparing a decoction of this kind, a long previous digeſtion, or the addition of a fixed alkaline ſalt, and, afterwards, or longer boiling are required; as hath been obſerved in making the decoction of *guaiacum* wood.

6. But even ſuch reſinous vegetables, if boiled when they are freſh, green, and ſucculent, their native ſaponaceous virtue ſtill keeps their roſin ſoluble, which running together, when dry becomes more difficult of ſolution. This has been obſerved by thoſe, who, in *America*, have boiled the chips of green *guaiacum* in water, whereby they ſoon obtained a very penetrating liquor which cures the venereal diſeaſe; whilſt the wood that has been long kept, being now leſs ſoluble in water, has a leſs effect.

7. Since, therefore, plants loſe by boiling all that which goes off in the form of vapour with 212 degrees of heat; all thoſe plants are unfit for this operation, whoſe virtue required is volatile with this degree of heat. But thoſe, whoſe virtue reſides in a more fixed matter than can be ſeparated by this heat, are fit for decoction. Of this kind are the following acid, aſtringent, viſcous, aromatic, emollient, cooling, nutrimental, reſtorative, and ſaponaceous vegetables, and all viſcid ones that are not too reſinous.

—Acacia.
—Barberries.
—Brook-lime.
—Cinquefoil.

(*a*) See proceſs 15. 23——30.

—Com-

—Comfrey.
—Cranes-bill.
—Currants.
—Dandelion.
—Dwarf-elder.
—Endive.
—Fern.
—Fumitory.
—Gentian.
—Grafs.
—Ground-ivy.
—Hellebore.
—Hypociftis.
—St. John's wort.
—Knot-grafs.
—Myrtle.
—Nettles.
—Plantain.
—Perriwinkle.
—Poppies.
—Purflain.
—Quinces.
—Rofes.
—Rhubarb.
—Scordium.
—Shepherd's purfe.
—Sloes.
—Sorrel.
—Speedwell.
—Succory.
—Sumach.
—Tamarinds.
—Tormentil.
—Water-lily.
—Wood-forrel.
—Wormwood.

To thefe may be added the frefh exprefs'd and unfermented juice of fummer-fruits.

8. Let it however be carefully obferved, that I do not fuppofe that the peculiar virtue of a plant, which commonly refides in its prefiding fpirit, fhould always fhew itfelf by fome remarkable odour, fragrance, or aromatic tafte: on the contrary it may happen, that the fpirit fhall be extremely active without remarkably affecting the fenfes; as appears in the black helebore root, the *cicuta aquatica Gefneri*, the *folanum maniacum*, &c. whence all thefe particulars are very cautioufly to be confidered before any general rule is laid down.

The nature, virtues, and effects of thefe infufions and decoctions.

1. Thefe preparations may pafs through the lacteal and mefenteric veffels, and mix with the venous blood of the *vena cava*, and thus by the vital motion be mixed with the humours of the body, received into all the larger kinds of veffels, reach to the vifcera, and all the other parts of the body; for they are faponaceous, penetrating, and mifcible with every humour.

2. And here they may act by their own peculiar force remaining in the liquor of the infufion or decoction; which faculty of action is then greatly encreafed by the force of the vital motion, and thus produces fudden effects.

3. But they want that efficacy which remains in the water of our firft procefs, tho' the infufion contains more of it than the decoction. But in the decoction, however, this want is fupplied by a greater efficacy, which the boiling heat communicates thereto, by enabling it to diffolve, and intimately mix the virtues of the plant with the water by long boiling. Whence, if the operation were performed in a ftill with its alembic head, and the exhaling water returned to the remaining decoctions, then thefe decoctions would

would become exceeding rich in the virtues of the plant; as will evidently appear in the *fifteenth procefs:* for fuch a liquor will contain nearly all the powers of the fubject.

4. It muft be well confidered, that the medicinal virtue of infufions and decoctions depends as much upon the efficacy and quantity of the hot water received, as upon the virtue of the plant. This is known to phyficians. Were it not an error, in condemning the ufe of tea, to attribute the mifchief wholly to the leaves, when the larger part is hot water: and again, when we attribute the virtue of enlivening the fpirits to the drinking of tea, is the diluting virtue of hot water to be omitted?

5. Hence may be underftood the pharmaceutical law, method, inftrument, fubject, and effect of preparing infufions and apozems; as alfo the efficacy of the hotteft water upon the folids of a plant. Who, but an eye-witnefs, would believe that a two days boiling fhould not, with all its force, deftroy the tender leaves of rofemary? nay, what is more, tho' the tendereft flower were to be ever fo long boiled in water, yet, upon taking it out, and carefully examining it by the eye, or even with a microfcope, it will be found perfectly unaltered. I have made the experiment, and continued the boiling for a very long time, yet at length found all the hairs, little rifings, tubercles, and fibres the fame, without any difference. From hence phyficians may underftand, why the fmalleft veffels of our bodies are not diffolved by the hot juices they carry. Some may fufpect, that the mechanical triture, which the force of the pulfation makes againft the fides of the canals, fhould rather break them, than the power of heat or moifture; but the laft elements of our folids are not fo much faline, faponaceous, or oily, as merely terreftrial, and joined together by a certain cement. For what we have above faid, concerning the force of boiling water upon vegetables, is alfo true of the parts of animals, treated in the fame manner.

6. If the leaves remaining after this operation be dried, they become fhrunk, and fmall; but if again fteeped in hot water, they exactly recover their former fize and figure.

7. But fome of the peculiar virtues of plants are altered by the boiling. *Arum* grows milder by decoction; the crude juice or infufion of *afarabacca* proves ftrongly emetic; but this virtue, by long continued decoction, is changed to another, that is diuretic and aperient.

PROCESS III.

The fapa, defrutum, extract, rob and jelly, from the produce of the fecond procefs.

AFTER having examined the infufions and decoctions of our fecond procefs; the law of method requires, firft, to try what will remain upon evaporating the water employed in thofe preparations; for thus that part of the plant will gradually appear which gave it its virtues, and thence may

may alſo be chemically known the nature of all thoſe parts of vegetables, which are ſoluble in hot water, and may be extracted by its means.

'1. Let the infuſions or decoctions of our ſecond proceſs ſtand at reſt for 'ſome hours, in a cool quiet place, and in a clean veſſel covered on the top, 'that they may thus depoſite their gravelly earth, and other groſs or ponde- 'rous feculencies, not belonging to the plant itſelf. They may alſo be paſſed 'through a ſtrainer till they become clear; but then the gummy, ſomewhat 'reſinous and viſcous parts belonging to the plant will be alſo ſeparated; and 'thus indeed they may be obtained the purer for medicinal uſe; tho' they 'loſe ſomething requiſite in their chemical examination. The apothecaries, 'requiring them extremely pure, have another method. They intimately mix 'the recent white of eggs with their decoctions, by long whiſking them toge- 'ther, then boil the whole, whereby the white of the eggs, now hardened by 'the boiling, concretes together in the decoction, and at the ſame time en- 'tangles the groſſer matter with itſelf: ſo that now the liquor being ſtrained, 'leaves much groſs feculency behind, and paſſes ſufficiently clear. And theſe 'are the three ways of purifying decoctions, viz. by reſt, by the ſtrainer, and 'by white of eggs; the former whereof is ſuited to chemical examinations.

'2. Let the liquors, thus purified, be put into a clean cylindrical open veſ- 'ſel, or one that widens upwards, and ſet over a clear fire, and there kept 'nearly in a ſtate of boiling; ſo as to exhale, and acquire the conſiſtence of 'thick honey; with care to avoid boiling ſtrongly, for fear of exhaling off 'what ſhould be left behind, and to prevent burning at the laſt; which would 'deſtroy the virtue.

'3. The ſame preparations may be likewiſe obtained from the freſh expreſt 'juices of plants; particularly the juices of ſummer fruits, and ſucculent roots, 'ſuch as liquorice. Theſe ſubjects being taken ripe, recent, and perfect, and 'being firſt cleanſed, and bruiſed, the juice is to be expreſt, diluted with 'water, and purified by reſt, and the ſtrainer; and then to be exhaled in 'the manner above-mentioned, to the natural conſiſtence they had upon ex- 'preſſion. The juice thus freſh expreſt, or reduced to its natural conſiſ- 'tence, after having been diluted and ſtrained, may be called *muſt*: and 'when this *muſt* is boiled to an half, ſo as to be long kept ſound, and poſſeſſed 'of its natural taſte, it has been called *ſapa*; but if boiled till only a third 'part remained, it has been called *defrutum*, which may be preſerved ſtill 'longer without loſing its former nature. But when the liquor is at firſt ex- 'tremely well purified, and again gently boiled till a drop let fall on a cold 'plate grows firm and tranſparent, almoſt like ice, it is called *jelly*. If it have 'the conſiſtence of thin honey, it is called a *ſyrup*; if it be ſomewhat thicker, 'a *rob*. All theſe preparations are indifferently called *extracts*, which are 'therefore termed either liquid, thick, or even, ſometimes ſolid.'

The nature, virtues, and uſes of the preceding preparations.

1. All the foregoing preparations may be diſſolved in warm water, and then they reſemble the decoctions of the ſecond proceſs; tho' they have by their boiling loſt ſome of their former virtue.

2. They may be long kept without ſpoiling, even for years.

3. They retain much of the taſte of the vegetable, tho' the volatile part is loſt in the preparation.

4. They long preſerve the virtues of plants entire, and free from the incumbrance of their vaſcular parts: ſuch virtues we mean as remained in them after this preparation; for ſo much they long preſerve from corruption.

5. Hence it appears what it is that plants loſe by long keeping, and corrupting with age; for hot water extracts nothing from the plants ſo corrupted: all the juices being gradually waſht out of ſuch dead plants, which are reciprocally penetrated, diſſolved, agitated, and dried by the moiſture of the air, dew, rain, and heat of the ſun; whence they become effete and dry ſkeletons of plants. The worm alſo conſumes the juices of vegetables, ſo as at length to leave nothing but a mere ſolid, inſoluble, ſluggiſh, and terreſtrial part.

6. They who make long voyages, may receive great advantage from the productions of this proceſs. Sailors are ſubject to diſeaſes from the uſe of meats much ſalted, dried and ſmoked; which diſeaſes are remedied by the juices of fruits: and thus by diſſolving the jelly of oranges, barberries, cherries, quinces, lemons, *China* oranges, currants, grapes, rob of elder, rob of juniper, *&c.* in water; they may have a preſent remedy. Theſe preparations are alſo eaſily recruited when they touch at any fruit-iſland; and perhaps nothing would more conduce to the health of the *Britiſh* and *Dutch* ſailors, than a due proviſion of this kind.

7. It muſt, however, be obſerved, that the juices abounding with ſalt are difficultly preſerved, when thus thickned, from running in the air; ſalt being attractive of water. The method, therefore, is to keep them in well ſtopped glaſſes. And, laſtly, thoſe vegetable ſubjects are unfit for this operation, whoſe medicinal virtue is volatile.

PROCESS IV.

The calcination of the inſipid inodorous plant, remaining after the ſecond proceſs, but ſtill retaining its native figure; or its reduction to inſipid aſhes, of the ſame form with the plant.

AFTER having learnt what effects hot air and boiling water have upon plants, and what may be drawn from them by their means; we muſt next enquire, what effect the open force of fire may have upon the remains of our ſecond proceſs.

' 1. Take the vegetable ſubject remaining after the action of our ſecond
' proceſs, under the conditions there explained; (*a*) lay it upon a clean open
' iron veſſel or ladle, place this ladle upon a clear fire that yields no ſmoke
' to diſturb the operation; this being a particular that requires caution, be-
' cauſe ſomething ſaline might eaſily inſinuate. This fire ſhould be continued

(*a*) See proceſs 2. of the nature, virtues, *&c.* §. 5, 6.

' ſo

'so fierce, and so long, till thro' various degrees, all appears wholly ignited. 'First, a smoke ascends and grows gradually stronger; turning at length 'black, and as it were pitchy. Secondly, during all this time, there is a 'strong smell of burning, which encreases as the smoke encreases. Thirdly, 'when the pitchy smoke and fetid vapour at once break into open flame, 'the smoke ceases, and the scent also greatly diminishes. Fourthly, the 'plant becomes totally black before the flame arises, nor does it burn before; 'but as soon as it becomes perfectly black, it directly takes flame. Fifthly, 'when the flame ceases, the leaves almost lose their blackness, and become 'white, but where any thing black remains amongst them, live sparks are 'seen; but no flame in the leaves; and this sparkling continues so long 'as the least blackness remains. But when the preceding flame, and the 'subsequent sparkling have consumed all the blackness, there remains a white 'ash, which sparkles no longer with any shew of fire. Sixthly, it is here 'very remarkable, that after all this violence of fire and flame, the original 'form of the rosemary should remain in these white ashes; so that if such 'a leaf be examined, as it lies, by the microscope, it not only exhibits the 'natural form of the plant; but even the down, the hairs, the risings, the 'fibres, and the cavities appear as manifest, as if the plant were entire; but 'if moved, tho' but by the breath or a gentle touch, these leaves become 'dust, and have lost all their cohesive power.

'2. The ashes, thus carefully prepared, are perfectly insipid and scentless; 'put them now into clear rain water in a clean glass; boil them together, 'depurate the liquor, first by standing, and then by the strainer, and it will 'become limpid, inodorous, and entirely free from any thing saline, tho' 'tasting somewhat like a decoction of lime. If this liquor be exhaled in a 'clean vessel, it leaves no fixed salt behind, but only a little matter like lime. 'The remaining ashes are white, free from salt, and fixed in all degrees of 'fire; being merely terrestrial, without water, spirit, oil or salt. These ashes 'made into a paste with water, formed into little cups and dried, make the 'best kind of *tests*, as enduring the strongest fire. And all these particulars 'hold, whatever plant be used; so that the process is universal.'

The use of this process.

1. Hence we learn, that water boiling with as great a degree of heat as it can receive, may extract from a plant all that is saline, whether it be volatile, or fixed.

2. That no force of boiling, in any quantity of water, is able to separate the fixed oil, which here manifests itself to remain behind; first, by the gross odorous, bitter, black smoke, that presently turned into flame. Secondly, by the black colour of the plant, beginning to burn by the force of the fire; for this black colour constituted a coal, where the oil burnt by the fire grows black, rarifies, extends itself more upon the earth of the plant, and disposes it easily to catch flame or fire. Thirdly, by the open flame rising from, and supported by this black unctuous matter, and entirely consuming this black oil. And fourthly, by the sparks of fire which remained in this coal, after

the flame ceafed, fo long as any black unctuous matter was left; but when this was confumed, no more fparkling could be excited by art.

3. We hence fee, that this fixed oil cannot be feparated from a vegetable, without the help of an open fire, and a free air; for if our ladle were to be filled with the remains of the fecond procefs, and covered with an iron plate, and then committed to a violent fire, the plant would long remain black, brittle, and bitter, as a coal, but never become white. But, upon removal of the cover, it will burft into open flame, and fall down into white afhes.

4. That this oil joins the terreftrial elements of a plant together, fo as to make them cohere, but, when taken away, to leave them incoherent. For although the boiling water extracted fo much falt and oil in our fecond procefs, yet the remains held together as much as before; but when this laft oil was feparated, there remained not the leaft cohefion, but the terreftrial parts fpontaneoufly fell afunder. Whence the oil extracted from plants by water, is not that cement which gives them their cohefion, but this laft or more fixed oil. Poffibly, therefore, this laft kind of confolidating oil may be the fame in all vegetables, whilft that diffolved in the decoction is peculiar to each fpecies. Whence we have three kinds of oil in vegetables; viz. 1. An oily froth; 2. The oil diffolved in the decoction; and, 3. This confolidating oil, feparable only by a naked fire.

5. The other part remaining in vegetables after decoction is a mere fubtile earth, that neither coheres together, nor fuffers any change in the fire; being the fame in all plants, and in every refpect like the white afhes of calcined animal fubftances. And this earth it is, which gives an unalterable bafis to all vegetables and animals; for the affay-mafters make their tefts from thefe earths, both of plants and animals.

6. If water be poured to the afhes thus diffolved, they recover fome degree of tenacity, as we fee in the making of tefts; but if mixed up with a proper quantity of oil, they cohere more ftrongly; fo that earth and oil give folidity to plants.

7. That all the medicinal, nutrimental, and poifonous virtues of plants entirely refide in that part which may be extracted from them by water; neither the connecting oil, when joined with the earth, nor the earth alone, having any thing peculiar.

8. Therefore the longer, and the more any plants are dried, the more they lofe of thefe virtues. So that if a plant remain long expofed to the common open air, there will at length be nothing of it left befides an indolent earth.

9. And hence it is, that plants remain unhurt by the moift air, dew, rain, and the action of the fun, whilft fed by the earth; and that the utmoft force of boiling water cannot deftroy the tendereft flower, as being unable to feparate this ultimate oil from the elementary earth. The bafis therefore of plants and animals is earth alone.

10. Hence we fee that falt does not refide in the ultimate folid texture of plants, and therefore is in vain fought therein. And all thefe particulars hold alfo of the ultimate folids of animals.

11. The

11. The free admiſſion of air diſpoſes fire to ſeparate this ultimate oil from the earth; nor could fire alone, without air, have this effect even on the tendereſt plant.

PROCESS V.

The preparations of the third proceſs afford ſaline aſhes by calcination.

AFTER having ſeen the action of the naked fire on the remainder of the plant of our ſecond proceſs, we are likewiſe to ſee its effect upon the infuſions, decoctions, and extracts prepared in the third proceſs; that ſo by comparing the effects of the fourth and this fifth proceſs, we may learn the force and action of fire upon plants.

'1. Let the extracts, prepared in the third proceſs, be put into a clean 'iron ladle, ſet over a gentle clear fire, and by degrees be made perfectly 'dry: when they will appear black, ſlimy, and tenacious. When brought to 'this ſtate, and urged with a ſtronger fire, they by degrees emit more fume, 'and, at length, when the ladle begins to ignite, ſmell empyreumatical, af'ford a black, bitter, and groſs vapour, then take flame; ſoon after, the 'matter ſparkles in the parts where it ſtill remains black, and at laſt falls 'into a pale, yellowiſh aſh, tho' before it was exceeding black.

'2. Theſe aſhes, being in the ſame veſſel long continued on the fire, 'grow whitiſh, remain fixed, and become inodorous; but of a ſaline, ſharp, 'lixivious, and ſomewhat urinous taſte; and, when taſted, leave a little 'earth upon the tongue. If diſſolved in fair water, filtred, inſpiſſated and 'dried, they afford a yellowiſh ſalt, inclining to white, of a ſharp, fiery, 'lixivious, and ſomewhat urinous taſte; but the degree of ſharpneſs, and 'quantity of this ſalt differ according to the nature of the plant; and again, 'according to the ſtrength of the fire employed.'

The uſe.

1. Boiling water, therefore, diſſolves the oil and ſalt of plants, and the earth intimately adhering in them both.

2. But this oil being mixed with the ſalt of the plant, into a kind of ſoap, may in the plant be perfectly mixed with water; whence the native juices of vegetables are underſtood to be ſaponaceous.

3. When the water is ſeparated from this ſoap, its oil, which is inflammable, being now more urged by the heat, grows black, rarifies, and ſpreads over the ſurface of the ſalt; kindles into flame, conſumes, and leaves the ſalt deprived of its oil. Hence, the matter is a true vegetable coal, conſiſting of water, ſalt, and oil.

4. This oil gave the colour to the extract, and a thick black fetid vapour, and a black colour in the fire, and all the remaining odour; this alone being combuſtible.

5. Upon

5. Upon mixing the water of the firſt proceſs, the infuſion of the ſecond, and the ſalt of the fifth, a compound, of conſiderable medicinal virtue, may be obtained.

6. When ſharp, pungent, alcaline vegetables, of a volatile and fiery nature, diſcoverable by their forcing tears from the eyes, are made the ſubjects of this proceſs, all the ſame particulars happen; only ſcarce any ſalt remains in the aſhes, as being here volatile. We have inſtances hereof in onions, ſcurvy-graſs, horſe-radiſh, muſtard, &c.

PROCESS VI.

A recent plant, or the remains of the firſt proceſs, afford ſaline aſhes by calcination.

' 1. PUT a quantity of recent roſemary, or the remains of the firſt proceſs, into a clean iron ladle; ſet it over a clear fire, which is to ' be ſlowly encreaſed by ſmall degrees; and here, (1.) There will riſe a ' ſtrong-ſmelling, watry, colourleſs, and ſomewhat tranſparent fume of roſe- ' mary, which continues till the plant begins to turn black. (2.) When the ' plant is become blackiſh, there riſes a groſſer, blacker, ſtronger ſcented, ' and empyreumatical fume; at which time the whole appears black like ' a coal, which now immediately takes flame, burns and ceaſes to ſmoke; ' then glows, ſparkles, and leaves a white aſh, retaining the natural form of ' the plant, as in the fourth proceſs; from which the preſent hitherto dif- ' fers in no reſpect. (3.) Hence the oil of a plant thus acted on by the fire ' is always black; whether it be thrown off and agitated in the air, ſo as to ' form a pitchy ſmoke; whether it be extended and burnt upon the ſalt, ' earth, or both together; or whether this oily black ſmoke, ignited by the ' fire, or rolled rapidly round, conſtitutes flame; from whence eſcaping, it ' ſtill makes a black ſoot; and ſhews, that bright flame is no more than black ' oil reſolved into fire. But as ſoon as this unctuous matter of the plant, ' which at firſt turns black in the fire, is entirely conſumed, neither flame ' nor fiery ſparks can be then any way produced; and therefore in this ſtate ' the whole remainder or aſhes of all plants appear conſtantly white. (4.) The ' aſhes thus procured from the tender part of a plant, exactly retain the ' natural figure thereof, after having ſuffered all this violence of the fire; ' but when ſome very groſs part of a vegetable is burnt, the whole grows ' perfectly black, and becomes a coal; that part whereof which lyes ex- ' poſed to the air, being alone conſumed at firſt by the ſhining fire, affords ' white looſe aſhes; after which the black layer lying under the aſhes, is ' again conſumed by the looſe fire, and thus it proceeds ſucceſſively, whence ' the figure of the matter is at length deſtroyed by burning; becauſe ' the force of the internal fewel throws off the external parts, now turned ' into aſhes, from the center outwards, which does not happen in thinner ' ſubjects. (5.) When theſe aſhes are taſted, they are found ſharp, fiery, ' lixivious, and urinous upon the tongue: when diluted with fair water, ' the

'the filtred liquor by evaporation affords a falt as in the fifth procefs, 'tho' in a much lefs quantity. The part remaining in the filter is a mere 'earth, in a large proportion, as in the fourth procefs.

The ufe.

1. Hence it appears, that water affifted by the force of fire, diffolves only the juices of vegetables, without touching the folids.

2. That fire by itfelf, has fcarce a greater efficacy, and, when ufed alone, extracts lefs from vegetables; as thus leaving their falt behind.

3. That water even extracts much of what is inflammable, which when not extracted adds to the combuftible matter of vegetables.

4. That the faline part of certain vegetables is not rendred volatile by this fire, tho' the oil is, which adheres thereto.

5. That the oil and falt, naturally mixt in plants, are together foluble in water, fo as to remain united, tho' feparable by fire.

6. Therefore the juices of plants and animals in a healthy ftate contain a native foap; but if either the oil or the falt be feparate, then their juices become morbid; which *Hippocrates* obferved when he faid, *things wholefome when mixt, may be hurtful when feparate.*

7. The elementary difference of plants therefore confifts in their juices alone; the earth and cementing oil being common in them all.

PROCESS VII.

The native falt of plants from their frefh exprefs'd juice, by an example in forrel.

FROM the foregoing proceffes we learn the action of the air, water, and fire, upon the folid and fluid parts of plants; what may be produced from them by means thereof; into what they are feparable by thefe inftruments; and that a fixed falt may be extracted from vegetables. But we are now more carefully to examine under what peculiar form the falt of plants refides in their natural juices; of what different principles it confifts; and what are its properties; in order to diftinguifh betwixt the vegetable falts produced by nature in the vegetable kingdom, and thofe produced by chemical fires; which is a matter of importance. For nothing has occafioned groffer errors than the common opinion among the chemifts, that falts exift in plants fuch as they are thence produced by a violent fire. It is no fafe conclufion that a falt was contained in a plant, becaufe it was thence extracted, by the means of fire; the caution required in chemiftry will teach us to argue thus; fuch a falt was extracted from fuch a plant, with fuch a degree of fire; therefore there was in that plant a native matter, which when treated in this manner, afforded this falt; and that a fat and oily inflammable matter, intimately united with one that is merely faline, will afford a native falt.

'(1.) Take

'(1.) Take a large quantity of broad-leaved garden ſorrel, in the prime 'of its growth, a little before it flowers; let it be gathered early in the 'morning, and well waſhed from its ſand in fair water; cut it, bruiſe it, 'commit it to a clean linen bag, and ſqueeze out all the juice, in a ſtrong 'preſs. This juice will be very acid, green, and thick as *muſt*. (2.) Dilute 'it with ſix times its quantity of pure rain water, that it may the better 'paſs the ſtrainer; now filter it thro' a conical linen bag, returning it ſo 'often, till at length it becomes pure, thin, and limpid; at which time it 'will be gratefully acid. (3.) Put the liquor, ſo purified, into wide glaſs-'veſſels, and inſpiſſate it by a very gentle boiling, in a place free from duſt, 'and over a clear fire, till the remaining matter become almoſt as thick as 'recent cream, and ſtrongly acid. (4.) Pour this thick liquor into a clean 'urinal-glaſs, which it may fill up to within its neck, then gently pour on 'the top a little pure oil-olive, to the height of about the tenth of an inch; 'and thus let it ſtand at reſt for eight months, upon the floor of a cellar. 'By this means, the oil preventing fermentation, putrefaction, and ropineſs, 'a ſalt will be produced reſembling tartar; which nearly approaches to the 'natural ſalt of vegetables. (5.) The liquor, therefore, being now poured 'off, let the ſalt be a little waſhed by the quick and ſudden affuſion of cold 'water, to cleanſe it of its adhering ſlimy feculencies; then gently dry 'it, and it will be the native ſalt of the plant. (6.) This ſalt I never found 'alcaline, whatever was the herb that afforded it. It was manifeſtly in 'the juice, but ſeparated itſelf therefrom, and concreted into ſaline glebes. 'Upon comparing this ſalt with that produced by calcination in the fifth 'and ſixth proceſs, there is a great difference found in the colour, taſte, 'figure, and every phyſical and medicinal effect. The preſent ſalt reſembles 'the juice of the plant; whilſt the other is a creature of the fire, that did 'not pre-exiſt the ſame in the juice of the plant.'

2. This proceſs may be performed upon the juice of any other ſucculent vegetable; but a different ſalt will be always produced according to the different nature of the plant employed. If the juices were either manifeſtly and purely acid, or acid with ſome degree of auſterity, the ſalt will reſemble the tartar of acid auſtere wines. If a perfectly ſucculent plant were choſe, and neither acid or oily, as many medicinal ones are, the ſalt will be of another particular nature, perhaps reſembling nitre. Such a ſalt is afforded by brook-lime, endive, fumatory, dwarf-elder, graſs, knot-graſs, plantain, ſelf-heal, ſuccory, water-creſſes, water-lilies, *&c.* Whence the juices of theſe plants are greatly medicinal, as abounding with this kind of nitrous ſalt, ſo as to open inveterate obſtructions, reſolve the black bilious juice, and cure chronical diſeaſes. But when the viſcous juices of vegetables are uſed in this proceſs, as thoſe of purſlain, comfrey, or the like, their ſalt cannot be obtained, without a previous fermentation to diſſolve their tenacity. In like manner, all the juices abounding with oil are unfit for this purpoſe; for tho' they contain a ſalt, yet it is ſo entangled with the tenacious oil, as to prevent its uniting with the particles of its own nature, and forming cryſtals; for oil always prevents the cryſtallization of ſalts; and again, plenty of oil occaſions a loſs of ſalt, and *vice verſâ*, as well in animals

as

as vegetables; on which account thofe falts are not eafily obtained from fuch aromatic plants as abound in oil and balfam.

The ufe.

Hence we learn the nature of the falt thus obtained, as it is native in plants. It is foluble in water, compounded of oil and falt, frequently acid, and never alcaline: for when it is alcaline, it flies off in the boiling and infpiffation. It is moderately fixed, and eafily changed; it mixes with the juices, and enters many of the fine veffels of the body; where, therefore, it may exert its virtue. When dried, it in fome meafure burns in the fire, like the infpiffated matters of our fourth procefs, and afterwards goes into falt, like that of our fifth and fixth procefs.

PROCESS VIII.

The native falt or tartar of vegetables, from their fermented juice.

'(1.) THE expreffed juices of ripe fummer fruits being perfectly fer-'mented, and fo become wine, depofite their fæces, or lees 'barely by ftanding, and thus become bright. If now this wine be 'drawn into a clean veffel, and fuffered to reft for a long time, it produces 'in its body little fhining fharp corpufcles, moving about therein. Thefe 'corpufcles difperfing themfelves from the wine's center of gravity to every 'point of the furface, at length touch, and fix themfelves to the fides of 'the cafk, and thus cruft them all over, wherever the wine reaches. By 'degrees the liquor depofites more of this matter, which eafily fticks to 'the former, whereto it feems to be attracted, till at length the whole body 'of the wine contains no more of it. After this, if the wine, thus grown 'milder, be drawn off into another cafk, and frefh wine, fined down as 'before, be put into the cafk that was emptied, but ftill remains lined 'with its cruft, the fame kind of matter will be fooner generated, and 'grow to the former cruft, which more powerfully attracts it.'

(2.) This appears to be the true generation of that ftrange production, which is the genuine faline cryftals of the wine, tho' not like other faline cryftals found only in the bottom, but equally all round the fides of the containing veffel. This fubftance is in many refpects different from the lees of wine, tho' it feems nearly of the fame nature; but it is more fubtile, more pure, lefs earthy, lefs feculent, lefs unctuous, more difficultly foluble in water, and of a more acid tafte. The *Germans* call it by a very proper name, *wine-ftone*, but the chemifts, lefs properly, tartar. There is a great difference in it, according to the nature of the wine; the acid auftere kinds whereof afford more, but the fweet and oleaginous lefs. The wines, that have their fermentation ftopt before it was completed, afford a lefs quantity, and thofe perfectly fermented and become thin, a greater; as *Rhenifh* wine for example. The tartar of red wine is red, and of white wine white.

The use.

1. This is another way of obtaining the natural ſalt of vegetables; which ſalt is always acid and oily. It is eaſily changed into an alcali; it diſſolves neither in water, wine, nor vinegar, without heat, but remains like a ſtone therein; and like a ſtrong veſſel contains within its cruſt the wine from whence it ſhot. It requires a boiling heat before it will perfectly diſſolve in water; and then again, as ſoon as the water begins to cool it immediately begins to become ſolid in the water, and is then called cream or cryſtal of tartar. It requires twenty times its quantity of water to diſſolve it perfectly. It generates more elaſtic air in burning than any other known body, and yields a vapour that can no way be confined. It is a great corrector in thoſe bodies which abound with a ſharp bilious putrid matter; and hence becomes an approved remedy in acute diſeaſes. It cleanſes the firſt paſſages, without much diſturbing the more internal parts. With a corrupt acrimonious matter it loſes its acidity, changes into a very ſoluble ſubſtance, and hence becomes a good aperative remedy. Its other properties will appear, when we come to treat of it hereafter (*a*).

2. We may hence underſtand what ſalt that is, which reſides in the natural or fermented juices of vegetables; but we ſhall ſhew in our 55th proceſs that theſe ſalts, ſo generated, are eaſily reſolved by art into highly elaſtic air, a tartiſh water, a tartiſh and ſtrong ſmelling ſpirit, an oil the moſt volatile of any hitherto known, a groſs and fixed oil, a black alcaline coal, an excellent alcali, and an earth. Salts, therefore, do not exiſt pure in plants, but are always mixt with other matters. And hence we may begin to underſtand the nature of the chemical *analyſis* of vegetables.

PROCESS IX.

Salt from recent roſemary, calcined, after the manner of Tachenius.

' 1. PUT a quantity of recent green roſemary, with its leaves and ſtalks, ' into a large deep and clean iron pan; place an iron plate on the ' top, ſo as to preſs down the plant, and perfectly cover the veſſel; which ' being thus ſet on a moderate fire gently encreaſed, is at length to be ignited. Thus the plant will ſmoke, ſmell ſtrong, and be turned to a black ' coal. Add more freſh roſemary to what is already burnt; cover, compreſs, ' and proceed as before, till this alſo is turned to a coal, and repeat the ' operation till a ſufficient quantity is obtained. In the whole of the proceſs ' the plant muſt be carefully prevented from taking flame, by covering the ' veſſel cloſe, and perfectly excluding the air, which as ſoon as ever it ' enters, the flame burſts out. This operation is called cloſe calcination; ' and the ſlower it is performed, the better it ſucceeds. The plant will now

(*a*) See proceſs 54, 55.

' be

'be very black, and crifp, and bitter; fo that if boiled with water it makes 'a bitter liquor, that will fcarce yet afford any falt, but taftes empyreuma- 'tical, and proves fudorific; whence by fuch burning of a plant into a coal, 'the falt hardly appears either in the lixivium, or by the tafte.

'2. And now let the iron cover be removed, and the pot with the 'fcorched matter remain on the fame fire, when as foon as the free air is 'admitted, the black mafs will begin to ignite, and eafily take flame; but 'this is carefully to be prevented, and the ignition to be kept up by a 'due regulation of the fire. As foon as the upper part, contiguous to the 'air, has fparkled for fome time, it ceafes to be ignited, and then prefently 'turns white, but the parts buried under thefe white ones remain black, 'and ignited; whence the whole matter is to be carefully ftirred with an 'iron rod; that all thefe parts being fucceffively expofed to the air may 'grow white; fo that at length the ignition being general, the ftirring 'perpetual, and the whole expofed for a proper time both to the air and 'fire, it may be changed into one fimilar white mafs, which will then ap- 'pear fmall, ponderous, and univerfally white; and then there will appear 'no more fparkling, tho' the fire were increafed. But if a fingle leaf 'fhould ftill remain black, it would immediately fparkle, upon feeling the 'air, as before. When the whole fubject is thus made white, it has a 'fharp, urinous, and faline tafte, which never becomes pure in the plant, 'fo long as any blacknefs adheres to it; this being no other than mere oil 'that fhould be confumed by the fire, and when it is totally confumed, the 'falt, which remains untouched by the fire, begins to appear naked. Whence 'we have it farther confirmed, that the oil muft be confumed before the 'falt can be prepared.

'3. Let the afhes, fo procured, remain for an hour or two over the fire, 'fo as to be kept perpetually ignited, and ftirred with an iron rod. And 'when thefe three particulars are rightly performed, then is the calcination 'of vegetables finifhed for preparing the falt of *Tachenius*. And here this 'ftifled action of the fire drives off the water, intimately unites the falt and 'the oil into a faponaceous fubftance; tho' it is ftill mixt with a large pro- 'portion of very fubtile earth.

'4. Put thefe afhes into a clean iron veffel, along with fix times their 'weight of pure rain water, and boil them over the fire, frequently ftirring 'them with an iron ladle. The floating liquor will thus become fharp, lix- 'ivious, and faline, by imbibing the falt out of the afhes, and leaving the 'earth at the bottom. Let this liquor be ftrained hot, till it becomes per- 'fectly clear, and afterwards be kept under the title of the lixivium of '*Tachenius*'s falt. The earth remaining at the bottom of the veffel, and in 'the ftrainer, being boiled with frefh water, affords a lixivium, tho' this 'contains lefs falt, and rather approaches the acrimony of lime; it may be 'ftrained and mixed with the former. The remaining earth may ftill be 'boiled with frefh water, and the liquor treated as before, till the water 'comes off as infipid as it was poured on. The latter lixiviums may be 'either filtred and preferved, or elfe thrown away as ufelefs. Let the pure 'earth that remains be ftirred well with rain water, and the turbid part

'poured off; this operation being repeated, till nothing but ſand remains at 'the bottom, which may thus be perfectly ſeparated from the true aſhes mixt 'with the water. Let the earth ſubſide from the muddy waters, and be 'afterwards dried: it will be the pure elementary and almoſt virgin earth 'of vegetables, and proper for making of teſts.

'5. Let this pure lixivium be boiled in a clean iron veſſel, till it be'comes perfectly dry; obſerving to ſtir it continually at the laſt, leſt it ſtick 'too much to the veſſel. The ſalt it thus leaves will be ſharp, ſomewhat 'alcaline, browniſh, and gradually relent in the air: tho' not ſo readily as 'perfect alcaline ſalt. The browner this ſalt is, the better it was prepared; 'as having more of the oil.

'6. This ſalt being put into a clean crucible, and ſet in the fire till the 'crucible be well ignited, eaſily flows like water, or much ſooner than true 'alcaline ſalt, and ſhould now be poured out upon a clean copper plate: 'and this is the pure vegetable ſalt of *Tachenius*.

'7. If it be required purer, it may be expoſed to the moiſt air, or diſſolved 'in fair rain water, then filtred and evaporated to a pellicle; when being 'ſet in a quiet place, it will ſhoot into pure ſaline cryſtalline glebes. 'Theſe ſalts contain not acrid alcali, but the oil of the plant here mixed 'with the alcali, renders it a milder ſalt. But we are not to expect the 'particular virtue of the plant in the ſalt thus prepared; for this is driven 'away by the fire along with the volatile preſiding ſpirit; and therefore the 'commoneſt herbs, if but rich in ſalt, being thus treated, yield this pre'paration as perfect as the dearer; their medicinal effects being certainly 'the ſame. But the colour of this ſalt is eaſily changed in the melting, if 'any coal ſhould fall into it, upon which a lead colour would immediately 'enſue, and prove different according to the quantity of the coals.'

The uſe.

1. Theſe ſalts are not corroſive or fiery, but of a ſaline nature, compounded of oil intimately mixed with corroſive alcali by the fire: and they recede the more from corroſive fiery alcali, and prove the more medicinal, the longer the plant was torrified, and the more the air was excluded.

2. They are not therefore ſo oppoſite to acids, as to deſtroy ſo large a quantity of them as fixed alcalies will; but if rightly prepared, they may in ſome meaſure ſupply the want of ſea-ſalt for ordinary uſes. Thus *Varro* relates of certain people upon the *Rhine*, that they uſed ſalt prepared from certain wood-coals calcined, inſtead of ſea-ſalt (*a*).

3. If theſe ſalts be long expoſed in open veſſels to the external air, they attract moiſture and diſſolve, tho' much more difficultly and ſlowly than pure alcali; but they readily diſſolve in water.

4. They alſo readily mix with all the juices of the body, even with the fat and inſpiſſated bile, by means of the vital heat, and the action of circulation.

(*a*) See *Varro* de re ruſtica, lib. 1. cap. 7.

5. Hence

5. Hence they may be received into the blood-veſſels, and thoſe of the ſerum, milk, lympha, urine, ſweat and bile, but not into the nerves.

6. By the help of mixture, heat, diluting, and the vital motion, they may diſſolve many coagulations, particularly thoſe found in the juices of the body; eſpecially if aſſiſted by exerciſe, frictions, and riding: but they do not eaſily diſſolve the ſtone in the bladder, as a *menſtruum*, tho' they leſſen it, by means of the motion and mechanical friction which they increaſe in the body, and principally in the urinary paſſages. Neither can they reach the diſeaſes ſeated in the nervous fluids, and therefore do not directly cure the confirmed gout: in other reſpects, when diluted with hot water, and agitated by the motion of the body, they penetrate deep into it.

7. When theſe ſalts are received and mixt with the juices of the body, they have a corroſive effect, tho' not deſtructive, but ſharper than the natural: whence they ſtimulate the more ſenſible parts of the nerves, and excite them to perform their vibrations with more than ordinary force; on which account they are highly ſerviceable in ſluggiſh hypochondriacal and hyſterical diſorders, and ſuch as ariſe from mere inactivity.

8. They therefore have extraordinary effects in opening the obſtructed veſſels of the body, whilſt they agitate the nervous ſyſtem, and at the ſame time diſſolve the groſſer matters, and urge every thing in their way with a weight and force greater than thoſe of the natural ſalts of the body.

9. And hence they exert their virtue in promoting all the ſecretions and excretions; for as they eaſily render the fluids more thin, and clear the cavities of the veſſels, they at the ſame time ſtimulate both the fluids and the ſolids; and therefore equally excite the true cauſes of the motion of the juices thro' the veſſels, whereon all ſecretion and excretion, in every part of the body, depend.

10. Hence appears why they are ſudorific; ſince it is certain that the ſweat naturally contains the native ſalts of the body, and depoſites them upon the external ſurface of the ſkin, thro' the minute open arteries in the cuticula; whence there is a paſſage open for theſe ſalts even to the ſkin, whereto the faculty of excretion reaches, as is clearly manifeſt by experiments.

11. Theſe ſalts are remarkably diuretic, for the kidneys are ſo formed as to diſcharge the ſuperabundant ſalts out of the body; as evidently appears from this, that the urine is the moſt ſaline of all the animal juices: whence the operation of theſe ſalts is in nothing more evident, than in promoting a diſcharge of urine, and at the ſame time cleanſing the humours from any peccant foulneſs.

12. They alſo looſen the belly, reſolve concretions, open the paſſages, and expel all ſluggiſh matters. The coſtiveneſs of hypochondriacal men can be no way better remedied than by a well regulated and a well directed uſe hereof, continued for ſome ſufficient time: for in this reſpect, theſe ſalts have this extraordinary and particular virtue, that when coſtiveneſs is once remedied by their means, it does not return; which is not the caſe of other purgatives. The whole bilious ſyſtem, the liver, the ſpleen, the bladder, the biliary ducts, and the *vena porta* have ſcarce a ſafer and more effectual remedy

medy to relieve and help them. Certainly this lixivious ſoap diſſolves the viſcid obſtructions of the paſſages, and cleanſes them without violence; ſo that by their means may be obtained that coction or preparation of the humours, recommended by *Hippocrates*, before they ought to be diſcharged.

13. Hence we ſhould obſerve the curative virtue of theſe ſalts in all thoſe chronical diſtempers, attended with a mere torpidity of the ſpirits, a ſluggiſh laxity of the fibres, an inactive thickneſs of the juices, without a putrid acrimony, an acid ſharpneſs from a weakneſs of the vital faculties, and a coagulation from any thing acid or auſtere. Certainly, a large number of diſeaſes proceed from theſe cauſes; whence the cure of many chronical caſes may be effected by theſe ſalts, which deſtroy acids, turn them neutral, then ſtimulate by this new virtue, and diſſolve viſcidities. But we muſt not raſhly imagine their uſe always proper and innocent: it is adding oil to the fire to give them in putrid, bilious, alcaline diſorders, attended with great commotions, and great heats thence ariſing. They are alſo prejudicial to thoſe of ſo weak a conſtitution, as not to be able to bear their effect, or to ſuſtain with ſafety the motion they excite, and likewiſe where the body already abounds with ſalts.

The method of uſing theſe ſalts in medicine.

1. They are to be taken upon an empty ſtomach, after digeſtion is performed, and therefore ten hours from the laſt meal. Their doſe is from four grains to two drams, or more, according to the diſcretion of the phyſician, and the difference of intention.

2. They muſt be diluted with a large proportion of water, leſt they ſhould otherwiſe, upon their firſt contact, hurt the jaws, the throat, or the ſtomach: let therefore a dram of the ſalt be diſſolved in nine ounces of common water; for thus they will act like thoſe mineral waters, which have their effect by means of a little foſſil ſalt in a large quantity of water.

3. If the deſign be to purge, let the patient over night take three pills, conſiſting of nine grains of waſhed *ſocotrine aloes*, or half a dram of the *pilulæ Rufi*; let him riſe early the next morning, and walk a little in the cool air, but prevent ſweating, and drink, whilſt he is walking, a proper quantity of the liquor, divided into five or ſix doſes; which will have an excellent effect, and purge and relieve without debilitating. This is the true cure for the coſtiveneſs of the ſtudious; and is able to extirpate deep rooted diſeaſes that yield to no other purging.

4. If the kidneys and blood-veſſels are to be cleanſed, proceed as before, only omit the *aloes* in the evening, and let the loins and hypochondria be more covered than the reſt of the body; the patient, between whiles, drinking a diſh of tea or coffee.

5. When the intention is to ſweat, let the patient take the liquor in the morning in bed, after the ſame manner; drinking after every draught ſome gentle ſudorific; ſuch as the decoction of burdoc root, the five opening roots, ſaunders, ſaſſafras, tea or coffee, and let the ſweating be continued in proportion to the diſtemper; the body remaining ſufficiently covered.

6. In

6. In order to cure ſtubborn, or autumnal intermittents, whether tertian or quartan, with theſe ſalts of *Tachenius*; let the patient be purged with them according to the above direction for two or three days ſucceſſively. Then four hours before the fit is expected, let him be ſtrongly ſweated in the manner juſt mentioned, about the time of the fit. And thus ſtubborn agues are happily cured: and in this particular the ſolution of theſe ſalts excels the *Spaw*, or other chalybeate mineral waters.

PROCESS X.

Tachenius's *ſalt from a dry plant calcined; by an example in carduus benedictus.*

'IF this plant be ſcorched by fire to uniform black coals, with the 'ſame apparatus as in the ninth proceſs; and a large quantity thereof, 'be then, in an iron pan, ſet over a clear fire, and turned into uniform 'white aſhes, without ſuffering any flame to appear, and theſe aſhes be 'afterwards a little calcined, then made into a lixivium, which being filtred, 'reduced to ſalt, and at length fuſed, there will a ſalt be obtained, like 'the former, made from a green plant.'

The uſe.

Since the oil and the ſalt, which plants have in common, are combined together in theſe ſalts, without retaining the ſpecific virtue of the ſubject, it is of little ſignificance from what plant they are prepared. Whence cheap and refuſe vegetables ſhould be uſed for making it. Thus dried bean-ſtalks, for example, being thrown on a heap, and preſſed down by iron plates, and ſcorched, in our method, by a gentle fire, will afford a ſalt of the ſame virtue, at a much eaſier price, and therefore principally to be recommended. But it has no peculiar medicinal virtue, tho' *Paracelſus* particularly prefers it before others in the caſe of the ſtone. We ſhould only obſerve not to chooſe the plants for this purpoſe too old, or too dry, becauſe they would thus afford little ſalt, and not be worth the labour; tho' otherwiſe the ſalt is ſooner, eaſier, and cheaper prepared from dry ſubjects.

PROCESS XI.

The ſalt from a calcined recent vegetable, in the common method of the trading chemiſts.

'TAKE any recent plant abounding in ſaline matter, as wormwood, 'carduus benedictus, fern, kali, bean-ſtalks, or the like; dry them 'in a warm air, ſhake off their adhering ſand and earth as much as poſſible; 'bind them into large bundles, and lay them on an heap upon a brick

'pavement;

'pavement; then light it in the open air, and fuffer it to burn with a clear 'crackling flame; throw more bundles fucceffively upon the ignited afhes, 'till the whole quantity intended be burnt to uniformly white afhes, as they 'will foon become by keeping them conftantly ftirred with an iron rod. 'Thefe afhes, being fifted, are thofe fold by the people who gather medi- 'cinal herbs for pharmaceutical ufes. Tho' the phænomena of this procefs 'are common, yet they deferve to be carefully obferved: and firft, when 'the plant is thrown upon the fire, it emits a fmoke, which by degrees be- 'comes more denfe and black; and when thickeft, blackeft, and in greateft 'motion, the flame fuddenly breaks out like lightning. An extremely lucid 'fire now plays in the flame, where no figns of the leaft fmoke or black- 'nefs appear. But, 2dly, the furface of the flame, as well the top as the 'fides, emits a black fmoke, with which they are furrounded, as appears, 'by holding a piece of white paper, or clean linen, above the flame. 3dly, 'It is remarkable, that the blackeft denfeft fmoke, whirl'd in a vortex with 'great velocity, fo nearly approaches to the flame, which immediately breaks 'out, as fcarce to differ from it; and when upon any caufe the flame ceafes, 'whilft black coals ftill remain in the fewel, black fmoke immediately fol- 'lows the flame; and thefe interchanges of flame and fmoke may be often 'repeated. 4thly, A flame may be made fo long as much blacknefs re- 'mains in the burnt fubject, efpecially by the force of a blaft; but there 'will always be lefs flame and fmoke, the lefs blacknefs there is; nor is 'there ever any ftrong flame before a blacknefs appears in the fewel. 5thly, 'When the blacknefs begins to be much confumed, no more flame can be 'excited; but ignited fhining fparks appear in every black particle, tho' 'without any vifible fmoke. Perhaps, therefore, fmoke, flame, fparks, the 'oil of the fewel, and the black part of the coals differ very little in their 'matter; for as foon as ever all the blacknefs is confumed, neither fmoke, 'nor flame, nor fparks remain. Perhaps, the difference is folely owing to 'the greater quantity of the fire, and more rapid rotation of the oil thence 'proceeding. The falt, procured from thefe afhes by the method above 'mentioned, is much more fharp, alcaline, and fiery, and therefore more 'corrofive, more oppofite to acids, and more difpofing to putrefaction.'

The ufe.

Hence we learn the difference of falts produced by fire, according to the different methods wherein it is applied, and are furnifhed with new inftruments of medicine and chemiftry of an alcaline nature, but not pure alcalies; it is alfo manifeft that of all the falts hitherto explained, the falts produced by this laft method differ by much the leaft from one another, and therefore may be prepared from any number of mixed plants fit for the purpofe: for the falts mixed together cannot be diftinguifhed from the falt of any one plant, whence the cheapeft forts are as fit for this purpofe as the deareft.

PROCESS

PROCESS XII.

The fixed corrosive, fiery, alcaline salt of vegetables, and its liquor, or oil per deliquium.

' 1. TAKE any recent, full grown, succulent and green plant gathered ' in the spring, and burn it, as for making *Tachenius*'s salt, to ashes, ' which will thus afford a large proportion of alcali, when treated according ' to the 9th and 10th process.

' 2. Or, because the increase of the quantity will scarce answer the trouble ' and expence, let it be burnt according to the 11th process.

' 3. Put the ashes into a large earthen vessel, and set them over a strong ' fire to ignite, taking care to prevent their fusion, because then they would ' run into glass, and afford no salt; otherwise, the longer they are thus cal- ' cined, the stronger alcali they yield; but then the alcali thus produced and ' made stronger, is the more disposed to dissolve the earth wherewith it is ' joined, and so become glass, and thus immediately lose all its alcaline na- ' ture: for the fire melting the fixed parts of vegetables mixes them toge- ' ther, and converts them into a fixed, transparent and perfectly tasteless ' gem, which is afterwards long unalterable, and apparently simple: whence ' the most ancient commentators on the bible have wrote, that at the last ' day, the frame of the world shall be dissolved by fire,and turned into glass. ' And if the fire be continued too long, or raised too high, a small quantity ' of true glass is often found at the bottom of the vessel.

' 4. Let these ashes boil in an iron pot with four times their weight of ' rain water, then standing to settle for half an hour, that the lixivium may ' become clear, pass it thro' a thick linen so often, till it appears perfectly ' transparent. Boil the fæces again with fresh water, often stirring them ' with an iron rod, and mix this lixivium, prepared as before, along with the ' former. Now, keeping back the fæces, boil the pure lixiviums in a clean ' and bright iron pot, till they begin to acquire nearly the consistence of ' honey. Then stir the whole strongly with an iron ladle to prevent its grow- ' ing to the pot in the drying; for if it be once fixed thereto, it cannot af- ' terwards be got off. When it becomes almost dry, the heat being in- ' creased, and the greatest part of the water discharged, the matter sudden- ' ly swells and rarifies, from the great increase of the heat for want of the ' water discharged; whence, unless carefully prevented by stirring, the mat- ' ter would boil over the pot to great loss and inconvenience. The stirring ' is to be continued till the salt becomes perfectly dry in the pot, white, ' alcaline, and pure; but it is difficult to procure it perfectly dry, and harder ' still to keep it so.

' 5. Put the salt thus prepared, whilst it is yet dry and hot, into a strong ' crucible, and melt it in a brisk fire, keeping it in this state for an hour ' or two; then pour it carefully into a metalline mortar made perfectly ' dry, clean, and hot: in the mean time, have in readiness a vessel of green

'glafs, made dry and hot, having a wide neck, and a large mouth. As 'foon as the falt is poured into the mortar, grind it well with a peftle be-'fore it grows hard, and thus it will be brought into a dry powder; which 'can be no otherwife procured, becaufe of its aptnefs to relent in the air. 'Then as foon as the powder grows lumpy, immediately put it hot into the 'dry heated glafs above mentioned; which is now immediately to be ftopt 'with a new dry cork ftrongly driven in. Laftly, dip the top of the bottle 'with its cork into melted pitch; and thus will a pure alcaline falt be ob-'tained.

'6. The ftronger and the longer this falt flowed in the fire, the more 'fharp and fiery it will become, and thus conftantly change of different co-'lours; being at firft grayifh, then white, next bluifh, afterwards greenifh, 'brown, and at length reddifh or marbled; and the fucceffion of thefe co-'lours, proceeding only from the force of the fire, always denotes a greater 'degree of acrimony, or a more alcaline nature. There always feems to re-'main lefs of the oil of the plant in this falt, the greater and the more vio-'lent fire it fuftained. Hence, if we defired diftinctly to obferve all thefe 'differences of the falt, the procefs might be divided into fo many parts, 'as we have fet down different degrees of colour and fharpnefs. But here 'the operator muft be careful that he be not deceived by the colour, pro-'ceeding from the falling in of the coals; for we here underftand that co-'lour alone which proceeds entirely from the fire.

'7. In the fame manner the juices, extracts, and native falts of vege-'tables, the tartarous falts that fhoot from fermented liquors, and the falts 'of *Tachenius*, all afford the alcali now defcribed, if treated with the fame 'fire.

'8. There is, however, a remarkable difference in the production of thefe 'falts: for fome plants afford them readily in plenty, and immediately, of 'an exceeding fharp alcaline nature: the cuttings of the vine at the begin-'ning of *March*, being burnt in a ftrong fire, give a copious and ftrong al-'cali; which *Bafil Valentine* feems to have preferred to all others for pre-'paring his two medicines againft the gout and ftone. So likewife the *Kali* 'of *Egypt* is rich in fuch falt, tho' it can be prepared from nothing 'fooner or better than from tartar; and the alcaline falt fo made, was judg-'ed the beft both by *Paracelfus* and *Helmont*. The glafs-makers obferve, 'that the glafs made of the falt of fern is of a dark green, but with the 'falt of *Kali* extremely clear; whence this latter falt is recommended for 'making the fineft glafs (*a*). And in the Duke of *Tufcany*'s court they dif-'covered upon examination a certain difference in the cryftal glafs hence 'prepared, and found different colours arife from a mixture of fuch diffe-'rent alcalies with a folution of mercury-fublimate in water, and the vi-'triol of iron (*b*); fo that fome fmall difference may proceed from the dif-'ferent origins of this falt, but much more from the different manner of 'its preparation.

(*a*) See *Neri* and *Merret*.

(*b*) See *Tachen.* Hippocrat. chem. cap. 7. and 16. and *Borrich.* contr. Conring. 350,—361.

'9. The

9. The ſalt, thus prepared, has theſe properties. (1.) It has a fiery taſte; for if a little piece of it be laid upon the moiſt tongue, it gives the ſame ſenſation as a little fire-coal would do, cauſes a ſudden inflammation, and an eſchar, which leaves a little ulcer behind it. But when diluted with water, ſo as not to prove hurtful when held in the mouth, it taſtes like putrefied urine; whence theſe kind of ſalts have been called urinous; tho' this only proceeds from the ſalt abſorbing the acid of the *ſaliva*, whilſt the other alcaline part thereof becomes volatile, and gives the ſenſation. (2.) This ſalt affords no ſenſible odour whilſt it remains unmixt; but if added to any ſaline ſubſtance, whether of the nature of the native animal ſalts, or ſal-ammoniac, their acid part is immediately drawn into this alcali, whilſt the other being freed from its fixing acid, always proves volatile, urinous, fœtid, and as it were putrefied: whence again chemiſts have called this ſalt urinous, being led thereto from this ſudden change, which they falſly attributed to the alcali; becauſe ſuch an odour is found in neither before mixing, and becauſe the animal juices immediately upon the application of the ſalt acquire this new ſmell and taſte. (3.) It is of various colours, but commonly white or bluiſh (*a*). (4.) Theſe ſalts ſeem unctuous to the touch, and when diſſolved in the air, afford an unctuous liquor, which the chemiſts therefore call by the name of oil *per deliquium*. (5.) If a piece of this ſalt be applied to the moiſtened ſkin, ſo as to remain fixed in one place, and be covered on the outſide to keep it from falling off, it preſently diſſolves by the natural moiſture continually tranſuding thro' the body, and being agitated by the natural warmth thereof, cauſes an itching, a heat, redneſs, a burning pain, a ſhining tenſity, a real inflammation, a hard and black gangrene, and an eſchar, deep in the ſolids of the body, ſo as truly to act like fire therein. It alſo turns the bones white; and if bones be boiled in a lixivium of this ſalt, they remain white when dried. Again, as fire ſoon putrefies the parts of animals, ſo likewiſe our alcaline ſalt ſuddenly brings on a fœtid corruption, if mixt with them; whence in this reſpect this ſalt, when pure, acts like poiſon, and deſtroys the animal ſtructure irrecoverably; and therefore is a highly dangerous ſalt to the body, and imprudently recommended as a ſafe remedy by the modern phyſicians. (6.) If mixed with an acid diſſolved in water, it preſently produces an ebullition, a hiſſing, and an inteſtine motion; at the ſame time generating and diſcharging a large quantity of elaſtic air, but at length with a certain proportion of the acid, the tumult ceaſes, and cannot be recovered by a freſh addition: and this always happens either ſooner or later; for tho' the ſharp alcali of tartar does not preſently manifeſt an ebullition upon a ſmall affuſion of vinegar, yet it does ſome time after. (7.) When ſuch a fixed alcali is mixt and agitated with the juices of the body, by means of the vital heat, it unites ſomewhat intimately with them all, diſſolves and thins them, joining their acid part to itſelf, and making their ſaline part alcaline, which before was neutral or ammoniacal, ſharp inſtead of neutral, extremely volatile inſtead of half-fixed, leſs oleaginous inſtead of ſaponaceous, and putridly fœtid inſtead of inodorous. But if boiled

(*a*) See above, §. 6.

with milk, this is coagulated thereby; tho' it rather thus diffolves all the other juices of the body. When therefore by the motion of circulation it comes together with the juices into the fmall veffels, it corrodes them by its acrimony, particularly the lungs. It likewife diffolves the gummy, refinous, oily and vifcous parts of vegetables and animals, as alfo the foffil oils and fulphurs, and opens, attenuates, and diffolves the vifcofities they form. (8.) Being boiled, or long digefted in any oils, with the affiftance of the air, or water and heat, it is intimately united, and may by art be turned into true foap, thus lofing its acrimony, and at the fame time deftroying the tenacity of the oil, and rendering it mifcible with water. (9.) Being long fufed in the fire with fand, or powdered flints, in a certain proportion, it intimately mixes therewith, and becomes glafs, wherein not the leaft fign of the falt appears. This transformation is very extraordinary, and if not common, would be efteemed impoffible. But when this glafs is again melted with thrice its weight of the ftrongeft fixt alcali, it may afterwards be diffolved and diluted with water, and leave its fandy part precipitated by the addition of a ftrong acid, which here drinks up the alcali; according to the obfervation of *Helmont*. That this fhould happen becaufe the fand contains a latent acid, is perhaps too fubtlely imagined by *Tachenius*. It is plain that the fand and alcali are here united; but whether it depends upon the acid of the fand, or upon the vegetable alcali alone, feems hitherto uncertain. (10.) This *fixed alcali* is a true magnet, or attractive of water, fo as to grow foft, moift, fpongy and tumid, by attracting the vapour of the air; at length diffolving and running therewith into a fat, thick, and, in fome meafure, tenacious liquor, called alcaline oil *per deliquium*; which being pafs'd thro' a paper filtre, fupported by linen, becomes exceeding pure, and the moft ponderous of all faline liquors, next to oil of vitriol. From this liquor the water may be recovered in its purity by diftillation: but acid particles floating in the air may be attracted by this falt, along with the aqueous, fo as to change its nature, and make it approach the nature of thofe falts that originally afforded the acid. Thus if the acid yielded by burning brimftone predominate in the air of the place, the alcali acquires the nature of tartar of vitriol; if the fumes of fpirit of nitre, fea-falt, or vinegar, it approaches the nature of nitre, falt, or regenerated tartar, refpectively. If rarified oil were to fill the place, the falt would then become a kind of foap. But fo long as this falt remains purely alcaline, it ftrongly retains all water, and parts from it with great difficulty; whence it is not eafy to dry it. (11.) This falt remains long fixed in the fire, tho' fufed thereby, provided it be contained in a veffel that does not run; yet by being long fufed alone, it at length vanifhes, efpecially if mixed with thrice its weight of calcined bones, or unvitrifiable earth, and long expofed to a violent fire; for in this ftate, being neither eafy to melt, by reafon of the earth which prevents it, nor eafily vitrifying with it, it becomes volatile, as the excellent Mr. *Boyle* obferves. (12.) When this *fixed falt* is exactly faturated with a pure acid, fo that neither in the leaft predominates, then by folution, filtration, evaporation, and cryftallization, it affords a true compound falt of that fpecies from whence the acid proceeded; infomuch that this has been taken

taken for the natural origin of ſalts; the mother alcali thus receiving the ſeminal acid, and ſerving as the univerſal *matrix* or chaos of ſalts. Whence ſome have called the alcaline ſalts female and the acid male. (13.) By its power of attracting acids to itſelf, it ſeparates them from other bodies, and hence produces many extraordinary effects. Thus the native and artificial vinegar of vegetables, the ſpirits of alum, nitre, ſalt, ſulphur and vitriol, are by its means converted into water, upon loſing all their acid part. And the ſalts thus made, are fixed; only that produced from vinegar proves volatile, as thus volatilizing the alcali. (14.) When fuſed with a proper fire, it is apt to penetrate thro' the pores of earthen, or even metalline veſſels, which it corrodes when made of copper or iron. And I have found iron thus eaten when I have covered the crucible with an iron-plate, which thence became brittle; but copper is ſooner conſumed. This fixed alcali precipitates metals diſſolved in acids: and thus it ſeparates the quickſilver in a ſolution of mercury-ſublimate, where the metalline part is held diſſolved by the acid of ſea-ſalt; the powder precipitated appearing of the brighter red, the ſtronger and purer the alcali is made; whence we have a certain method of trying the purity of this fixed alcali. This alcali being mixed with the juice of the ſun-flower, roſes, violets, &c. turns them green, as acids turn them red. (15.) This ſalt never appears in its own form either in animal, vegetable, or mineral ſubſtances, but ariſes from vegetables alone, treated with a violent fire, of which it is therefore the creature, produced in vegetables burnt to aſhes: for in this action it is always prepared. When mixed with aſhes, it turns into earth, and there appears no longer in its own nature; but by paſſing thro' the ſame revolution, it may again be formed into the alcali it was before. (16.) This ſalt being run *per deliquium*, then dried, again melted in the fire, and again run by the moiſture of the air, thus by repeated operations at length reſolves into earthy fæces, and a volatile part. And thus by faithful experiments we learn the nature of fixed alcali, ſuch as we theoretically deſcribed it in our *chapter of menſtruums*; which account being compared with the preſent, we may form a true judgment of the thing that has been ſo famous for theſe two laſt ages among chemiſts and phyſicians; and hence be ſurprized to ſee how little they knew of what they have both wrote ſo much about.

10. If we would juſtly relate the medicinal virtues of the preſent ſalt, the reſult will be this. (1.) It ſoon deſtroys all the acid in the body; this acid being there but little, mild, of a vegetable nature, and lodging only in the firſt paſſages. (2.) It makes an efferveſcence upon meeting with an acid in the body; thus exciting bubbles, and cauſing windy vapours, ſtimulating the parts by its motion, and turning to a neutral ſalt, which then becomes innocent, penetrating, aperitive, diaphoretic, diuretic, preſervative, and produces new effects, not properly aſcribed to alcaline ſalts, tho' they follow upon the uſe thereof. (3.) By the motion of this efferveſcence the nerves are ſtimulated, the ſpirits moved, and the former motion both of the nerves and ſpirits altered; hence the ſpaſms of hypochondriacal and hyſterical patients are often cured, with the diſtempers thereon depending, as we ſee in the famous anti-emetic of *Riverius*; which being a mixture of fixed alcali, and the

the juice of lemons, and drank in the act of its effervefcence, cures choleric disorders, and ftops violent vomitings that yield to no other means. (4.) It thins the juices that coagulate with acids, and has therefore excellent effects, being prudently given in coagulations of the milk (*a*). It alfo fuccefsfully diffolves other vifcidities. (5.) It attenuates glutinous, oily, and fat fubftances, rendring them mifcible with water, whence it has a cleanfing virtue. And hence, a lixivium of this falt has its fcouring property, as is obferved by *fullers*, *fcourers*, and *dyers*; and hence, by a moderate ufe, it cleanfes the whole fyftem of the chyle-veffels from their glutinous matter. (6.) It alfo diffolves the coagulations of the bile, lymph, blood and ferum, being carried to, and agitated among them by the force of the circulation. (7.) By its ftimulating virtue it excites the unactive parts, and thus promotes a difcharge of urine, fweat, and faliva, fo as to be accounted diaphoretic, diuretic, and fudorific; it alfo loofens the belly. (8.) It is therefore of excellent ufe in diftempers attended with fluggifh, vifcous phlegm, an acidity from vegetable aliment in the firft paffages, an auftere acid humour, manifeft effects of coagulation, a collection of watery ferum, unctuous and vifcid concretions, and in the difeafes frequently arifing from thefe caufes; as the dropfy, jaundice, *leucophegmatia*, gout, rheumatifm, and fcurvy: but it ought to be given cautioufly, well diluted, in a fmall dofe, and at proper times. Perhaps, that fpecies of the gout which proceeds from too great acidity, can fcarce be better cured than by a moderate ufe of this falt, continued for fome time; but it muft not hence be prefently commended as an univerfal remedy for the gout: for it proves hurtful where this diftemper happens in bilious conftitutions; the juices in this cafe fpontaneoufly tending to a putrid alcaline nature. (9.) This falt is of great fervice in chirurgery, where it is ufed for the making of iffues in the way of a cauftic; and putrid foul ulcers are excellently cleanfed by a mild lixivium made of it. If gangrenated parts be fcarified to the quick, and afterwards fomented with this lixivium, they grow crufty, may be eafily feparated from the found flefh, and thus the fpreading of the mortification is hindred, and often cured. It extirpates warts, and fafely eats away little cancers, and, if fufficiently diluted with water, it excellently takes away fpots in the fkin. (10.) But the ufe of all thefe falts is pernicious in thofe diftempers where the native falts begin to degenerate into a corrofive, alcaline, putrid, and volatile nature, and the natural oils of the body tend the fame way, known by a rank exhaling odour of the fkin, and the high colour of the urine; but they are then principally fatal when the bile is thus altered, and the juices too much diffolved, broke, and turn'd corrofive. Whence in the plague they are almoft immediate poifon, even in the form of foap. Their internal ufe therefore is to be wholly avoided in inflammations, fuppurations, gangrenes, fphacelations, continued putrid fevers, and difeafes attended with too great a velocity of the blood. (11.) To ufe them cautioufly, let a dram thereof be diffolved in twenty times its weight of water, and fcarce more than a dram of this be ventured upon for a dofe; which fhould be repeated with prudence, and a due obfervation, during the ufe, whether the farther occafion for it be not

(*a*) Tho' itfelf coagulates milk when boiled therewith, fee above §. 9. (7.)

ceafed,

ceaſed. And thus theſe ſalts may be advantageouſly uſed without danger. In the laſt place, their effects ought to be directed upon particular parts of the body, as was obſerved in giving the ſalt of *Tachenius* (*a*).

PROCESS XIII.

The highly corroſive, fiery, alcaline ſalt with quicklime.

'TAKE one part of quicklime freſh prepared from ſtone, and put it, 'whilſt it remains perfectly dry, ſolid, and uncrack'd, into a clean 'iron pot; lay upon it two parts of pure pot-aſh, ſo as every way to 'cover the lime. Cover the pot with a linen cloth, and leave it in this 'ſtate till the lime begins to ſplit; then add four times their weight of fair 'water, and boil them together for an hour or two. Strain the clear lixi-'vium thro' a cloſe linen bag made of a conical form, till it becomes as 'limpid as water; then inſpiſſate this lixivium in a large iron ladle, with 'care to prevent boiling over, till it becomes perfectly dry; making the 'fire ſo ſtrong at laſt as to ignite the ladle, and melt the matter, after it 'ceaſes to fume. As ſoon as it runs, pour it out upon an hot copper plate, 'and whilſt it is yet ſoft, make it flat, and cut it into little ſticks fit for 'chirurgeons uſe; put the pieces immediately into a ſtrong heated and dry 'glaſs, which muſt be directly ſtopt with a ſound and dry cork, and then 'be carefully cloſed over by having its upper end dipped in melted pitch, 'to prevent any moiſture from inſinuating; which with incredible force is 'attracted by the alcali ſo prepared, even thro' cork and bladder. But by 'this contrivance it may be kept perfect for years. When any part is taken 'out for uſe, this ſhould be done in a ſtrong heat, near the fire, and in a 'dry air; the glaſs being again immediately cloſed as before.'

The uſe.

1. The ſalt acquires a very ſtrong and quick corroſive power on this account, that the fiery fixed alcali attracts the fiery virtue of the lime: for no ſuch power reſides either in the alcali, or lime alone. This corroſiveneſs exceeds that of any other known ſalt; for if a little piece of it be applied to the ſkin, contained in a ſmall round hole cut in a plaiſter, firſt laid upon the part, and then covered with another plaiſter, it ſoon burns the ſkin and the fat; for which reaſon chirurgeons prefer it as their chiefeſt potential cautery.

2. While the freſh lixivium is boiling over the fire, it will immediately diſſolve almoſt any animal ſubſtance thrown into it, as alſo many vegetable matters, and foſſil ſulphurs. A man unfortunately falling into a boiling copper full of this lixivium, had his clothes, and all the ſoft parts of his body diſſolved, ſo that only the bones remained. But a prudent ap-

(*a*) See proceſs 9. method of uſing, &c.

plication of fuch a lixivium, is an incomparable remedy for difpofing deep gangrenated, and almoft fphacelated parts of the body to a curative feparation; tho' its application requires the caution of an experienced chirurgeon.

3. This falt melts and runs like wax with a gentle fire, and hence becomes fit for diffolving many things with a fmall degree of heat, which are otherwife of difficult folution, fuch as myrrh, gum-fandarac, &c. The ancient chemifts have wrote much upon the art of rendring fixed alcalies fufible, like wax, in the fire, under the title of *Inceration*; poffibly they might mean the prefent procefs, at leaft the falt it affords has this property.

4. If the lime were firft flacked either in the air or in water, as almoft all old lime is, or be already reduced to fine powder, it will not give this corrofive falt with fixed alcali. Even the falt itfelf, if once diffolved in the air, or if kept negligently ftopt, lofes its particular virtue, and depofites a large quantity of unactive ftony fæces, which did not appear before. Whence we learn, that indolent ftone, or animal fhells, may receive this corrofive power from the fire, tho' not otherwife eafily procurable. This might lead one to fufpect, that the vegetable falt likewife, when it changes from neutral, native, and faponaceous, to fixed alcali, receives its acrimony from the fire.

5. The falt of this procefs acquires this particular property, that it becomes extremely well-difpofed to unite with oils, whether expreffed, or diftilled, vegetable or animal, and thus forms foaps; being by the preparation rendered fo penetrating, as intimately to divide the body of oil, and unite therewith, which, unaffifted with the fharpnefs of the lime, it could not well do: nor will fixed alcali eafily melt at the fire without this affiftance.

And here the power of chemiftry upon fixed alcaline falts terminates; at leaft, I know not how to proceed farther in this fubject; and will therefore fubjoin a few corollaries to thefe proceffes.

COROLLARIES.

1. THE fixed falt of vegetables is produced by burning only proper fubjects of this operation: for fome plants, when burnt, fcarce afford this falt; and thofe fitted to afford it, lofe all the matter thereof by lying long expofed to the air, and being alternately dried and moiftened a number of times; for the perpetual motion of the fluid air, by drying and heating the fubject, in this cafe acts upon the matter of the fecond procefs, and carries it off; which fhews that what is fpontaneoufly volatile in the plant, becomes fixed in a calcining fire.

2. Fixed, vegetable, alcaline falt is obtained only by means of a fire that burns the fubject; for it is never found in the matter of our fecond nor feventh procefs, but only by means of a burning fire; and according to the different degree thereof, and different time of application, it becomes ftronger, more fixed and alcaline, according to our twelfth procefs. It's true, fomething alcaline appears in muftard-feed, by its manifeftly making an ebullition

ebullition with acids, but this is not fixed, but volatile, and vaniſhes in burning. Indeed, theſe two corollaries, which are neceſſary to be known, are ſupported by all the preceding proceſſes; which plainly demonſtrate that this fixed alcali is the creature of the fire.

3. Alcaline ſalt, therefore, is not the native fixed ſalt of the plant: I call that ſalt native, which is produced, by the particular nature of the plant, from the common nutritious juice of the earth, and therefore always remains in the plant, ſo long as this is left to its own nature; which is deſtroyed by the fire, and changed to another. Our ſeventh proceſs ſhewed, that ſorril abounds with a native acid ſalt; but when this plant is burnt in a naked fire, it affords a fixed alcali, tho' it before contained a manifeſt acid. This alcali, therefore, is not native, but made an alcali by the fire, from what was not an alcali before.

4. Hence we may underſtand what an alcaleſcent plant is: for, firſt, ſuch are ſo called whoſe juice ſmells ſharp, ſomewhat alcaline, and always volatile, as we find in garlick, onions, and the like. Secondly, thoſe which by a ſharp ſtimulating virtue increaſe the motion of the animal fluids in the veſſels, and thus cauſe the animal ſalts to degenerate, or incline to an alcaline nature; whence the ſharpeſt aromatics, tho' in themſelves not alcaline, yet give the ſalts of the body that tendency. And thirdly, thoſe plants from which the fire produces a large quantity of alcaline ſalt.

5. Hence there are numerous ſpecies of fixed ſalts between the native ſalt of our ſeventh proceſs, and that violently alcaline one of the twelfth; and differing from each other in their phyſical actions, and internal nature, and therefore to be diſtinguiſhed. For example, *Rheniſh* tartar is a perfectly acid, and ſomewhat ſharp native ſalt of wine; and hence extremely uſeful in alcaleſcent, bilious, and putrid diſorders. This ſalt being diſtilled in a glaſs retort, with a gentle fire, affords a little watery, tart and light liquor, which quenches thirſt; when this is come over, the matter remaining in the retort begins to grow alcaline, and would heat the body, and occaſion thirſt; if urged with a ſomewhat ſtronger fire, it affords a fragrant, penetrating, gold-coloured, bitter and heating oil; leaving a black maſs behind, more alcaline, heating, and more apt to excite thirſt; but being digeſted with ſpirit of wine, affords an excellent aperient, detergent, diuretic medicine, good in the dropſy. If the remaining matter be now urged with a ſtill fiercer fire, it yields a groſs, viſcid, bitter, fœtid oil, leaving a black coal at the bottom of the retort, much more alcaline; this coal being taken out, put into a crucible, and long urged with a violent fire, at length affords a fixed alcaline ſalt, which continually differs in all reſpects, but always grows ſharper, according to the ſtrength and continuance of the fire: in this inſtance, the ſalt was at firſt of a native acid nature, but at laſt is rendered highly alcaline.

6. There are three principal cauſes that contribute to this difference in theſe alcaline ſalts; the firſt is the quantity of inflammable oil ſtill adhering to the ſaline matter; for the more of this oil, the leſs ſharp the alcaline ſalt will prove, and *vice verſâ*. The ſecond proceeds from the artificial union of this oil with the alcali; for if the ſubject be ſlowly torrified with a ſtifled fire,

according to our ninth procefs, the lefs alcaline and fharp the falt will be, but in greater quantity; but if immediately burnt with the open flame of a violent fire, fo much the lefs in quantity, but the more ftrongly alcaline. The third caufe appears to be the proper action of the fire, which feems to fuperadd fomething igneous to the falt; whether it be by the fixing of the fire therein, or by its changing power, as we have explained it in our prefent procefs. It is certain, that the longer quicklime is burnt, and with a ftronger fire, the more heat, that is, the more true fire it excites in cold water. Perhaps a fourth caufe might be added, *viz.* the original and feminal property of the plant, not eafily to be deftroyed; for one plant affords much fixed falt, and another none at all; not, perhaps, becaufe this naturally contains lefs falt, but becaufe the plant would not fuffer it to be fixed; whether this be owing to the falt itfelf, to the oil, to the earth, or rather to them all together.

7. From the whole we learn the origin of alcaline falts in animals, by regarding the matter of their aliment, drink, and air: for animals, that feed wholly upon vegetables and pure water, take into their bodies the matter from whence we produce thefe falts; tho' no one would fufpect any thing fhould be contained in fo infipid a fubftance as grafs, that by bare burning becomes fo fharp, alcaline and fiery. Neither can the fame fubftance be difcerned in beer or wine, yet experiments will fhew it; and even the action of animal bodies will difclofe and manifeft it. The child that is fed with nothing but fweet milk, daily difcharges a falt acrimonious urine, not by generating, but by extricating the falt, or bringing it from concealment. The ox that feeds upon herbs, for the fame reafon, has a very faline urine: but by what means this falt becomes volatile in animals, we fhall fhew hereafter in treating upon the animal falts (*a*).

PROCESS XIV.

Corrofive, fixed, vegetable alcali yields a bitter cryftalline, hard, fixed, unalcaline, and fomewhat glaffy falt.

'PUT fix pounds of the beft pot-afhes into a clean glafs; add thereto 'twenty pints of cold rain-water; then ftir them about with a ftick, 'and fuffer the whole to reft: when the afhes are fufficiently diffolved, gently decant the clear lixivium, and there will remain at the bottom, mixed 'with the fæces, a number of fmall gray-coloured grains, of a bitter tafte, 'and almoft glaffy brittlenefs and hardnefs, that afford no figns of an alcaline nature: and the falt intended is procured. But to obtain it in greater 'purity; put fix pounds of *pot-afh* in a copper veffel, with four times its 'quantity of water, and ftrain all the lixivium very hot, thro' a linen bag, 'fo as to make it pure; then put it hot into a clean glafs veffel that is 'ready heated and moiftened, and fuffer it to ftand thus; when a dufky 'cruft will prefently begin to fhoot to the bottom and fides of the glafs, 'and gradually grow thicker and darker. At length, when no more appears

(*a*) See procefs 97, 98, &c.

'to shoot, gently pour off the liquor; and a salt like the former will re-'main behind, but purer, and in a large quantity. If the remaining lixi-'vium be now thickened by boiling, and set to rest as before, it may, per-'haps, afford a little more of this salt; but afterwards no more; whence 'there seems to be only one certain quantity of it contained in the alcali. 'If this salt be shook in a vessel of rain water, it does not dissolve; and no-'thing more than the alcali is thus washed off, so as to leave the salt per-'fectly pure. And if it be now gently dried, it becomes simple, and may 'thus be kept, under what title any one is pleased to give it.'

The nature and use of this salt.

1. It has long obtained among the skilful in chemistry, that genuine, fixed, alcaline salts could hardly be crystallized; which is true. But later writers have produced the salt of the present process for a crystallized alcaline salt; without properly distinguishing between them: for it may still be difficult to crystallize pure alcali, tho' crystals may be obtained from it.

2. This salt never runs spontaneously in the air, nor easily dissolves in cold water; when boiled, requires a large proportion of water to dissolve it; and when cool, presently shoots out of it again. It is hard, brittle, and reducible to fine flower, that remains dry. It is lastingly bitter to the taste. It cracks and leaps violently in the fire. 'Tis neither acid, alcaline, nor of kin to any salt hitherto known; tho' it seems to approach nearest to *Sandiver*. This may suggest a query, whether the fire in producing the fixed alcali, does not at the same time produce this salt from vegetables? or whether by combining the sand and alcali together in the making of glass, the fire does not again separate and throw up this salt in *Sandiver?* Something of this kind seems to be the case; whence we may, perhaps, understand why the alcali of tartar does not afford this salt; for tartar proceeds from a subtile liquor intimately fermented in its smaller parts. But a farther application of this salt to various bodies, by the means of fire, must teach its virtues and effects, which are not hitherto sufficiently known.

3. The fixed alcali perfectly separated from this salt differs greatly from that which remains mixed with it; which I always separate before I make any experiments that require the use of pure alcali, whose virtues otherwise would be often disturbed or hindered.

PROCESS XV.

The common distilled water of a fresh plant, by the alembic, shewn in rosemary.

OUR five first processes having shewn what substance remains in plants after such a force of fire is used, as, after the natural degree of heat is capable of being applied to them thro' water; the law of method requires that we should next enquire into that part, which, being separated

by

by the heat of boiling water, flies off into the air. The moſt commodious operation for this purpoſe is that performed by a ſtill-head, cloſely fitted in to the mouth of a veſſel, ſo as to collect and condenſe the vapour ariſing by the boiling heat, and tranſmit it, without loſs, into a receiver. It will hereafter appear what volatile matters are ſeparable from vegetables, by a heat greater than that of boiling water, even up to the higheſt degree our veſſels will ſuſtain (*a*). But that we may proceed diſtinctly, we are now to collect that which flies off from a recent plant by the natural degree of the ſummer's heat up to that of 214 degrees. And for this purpoſe, we ſhall again make choice of roſemary, that the operation may be duly compared with thoſe already performed upon the ſame ſubject; tho' inſtead of this, any other of the ſapid and odorous plants, enumerated as fit ſubjects for the firſt proceſs, might be here employed. All which, we ſee by the preceding proceſſes, contain an inflammable, oily, and a fixable ſaline part, as alſo a ſaponaceous one, conſiſting of the two. The plants deſigned for this operation are to be gathered when their leaves are at full growth, and a little before the flowers appear, or before the ſeed comes on; becauſe the virtue of the ſubject, expected in theſe waters, is often little, after the ſeed or fruit is formed; at which time plants begin to languiſh. The morning is beſt to gather them in, becauſe the volatile parts are then condenſed by the coldneſs of the night, and kept in by the tenacity of the dew, not yet exhaled by the ſun. This is underſtood, when the virtue of the diſtilled water principally reſides in the leaves of plants; as it does in mint, marjoram, penny-royal, rue, and many more. But the caſe differs when the aromatic virtue is only found in the flowers; as in roſes, lilies of the valley, &c. in which caſe we chooſe their flowry parts, whilſt they ſmell the ſweeteſt, which ſhould be gathered before they are quite opened, or begin to ſhed; the morning dew ſtill hanging upon them. In other plants the ſeeds are to be preferred, as in aniſe, carraway, cummin, &c. where the herb and the flower are indolent, but the whole virtue remains in the ſeed alone, where it manifeſts itſelf by its remarkable fragrance, and aromatic taſte. We find ſeeds chiefly poſſeſſed of this virtue when come to perfect maturity. We muſt not omit that theſe deſirable properties are found only in the roots of certain plants, as appears in avens, and in orpine, whoſe root ſmells like a roſe: and here the roots ſhould be gathered for the preſent purpoſe, at that time when they are richeſt in theſe virtues; which is generally at that ſeaſon of the year juſt before they begin to ſprout, when they are to be dug up in a morning. If the virtue here required be contained in the barks or woods of vegetables, then theſe parts are to be choſe for the purpoſe.

'1. The ſubject being choſe, let it be bruiſed, or cut if there be occa-'ſion, and with it fill two thirds of a ſtill, leaving a third part of it empty, 'without ſqueezing the matter cloſe; then pour as much freſh rain water 'upon it as will fill the ſtill to the ſame height, that is two thirds, toge-'ther with the plant. Fit on the head exactly to the neck of the ſtill, ſo

(*a*) See proceſs 32——36, 55, and 86.

'that

'that no vapour may pass thro' the juncture, which the copper-smiths can 'order to perfection. Let the joining of the nose of the still-head to the 'worm be luted with a stiff paste, made of linseed meal and water. Ob'serve, that the cavity of the worm, be always cleansed by passing fair boil'ing water thro' it, lest otherwise the distilled water should be fouled. Ap'ply a receiver to the bottom of the worm, that no vapour may fly off in 'the distillation, but that all the liquor, being cooled in the worm-tub filled 'with cold water, may be collected; which is best performed by keeping 'the worm-tub continually supplied with cold water.

'2. Things being in this state, digest for twenty-four hours with a mo'derate degree of heat, of 150 degrees. Afterwards raise the fire so as to 'make the water and the plant boil; which may be known by a certain 'hissing noise, proceeding from the breaking bubbles of the boiling matter, 'as also by the pipe of the still-head, or the upper end of the worm be'coming too hot to be handled; or the smoking of the water in the worm-tub, 'heated by the top of the worm; and lastly, by the following of one drop 'immediately after another from the nose of the worm, so as to make an al'most continued stream. By all which signs we know, that the requisite heat 'is given; and if it be less than a gentle degree of ebullition, the virtue here 'expected will not be raised: but when the fire is too great, the matter hastily 'rises into the still-head, and fouls the worm and the distilled liquor; and the 'plant being also raised, it blocks up the worm; for which reason it is pro'per to place a piece of fine linen artificially at the end of the still-head 'pipe, that in case of this accident, the plant may be kept from stopping up 'the worm. But even in this case, if the fire be too violent, it will throw 'up the herbs into the still-head pipe, whence the passage being stopt, the 'rising vapour will forcibly blow off the head, and throw the liquor and 'steam about, so as to do much mischief, or even to suffocate the operator, 'without a proper caution; and the more oily, tenacious, gummy, or resi'nous, the subject is, and consequently the more frothy and explosive, the 'greater danger there is in case of this accident.

'3. Let the due degree of heat therefore be carefully observed, and equally 'kept up, so long as the water distilling into the receiver proves white, thick, 'odorous, sapid, frothy, and turbid; for this water should be kept care'fully separated from that which will follow it; whence the receiver must 'be often changed, that the operator may be certain that nothing but this 'first water comes over; for there afterwards rises a water that is transpa'rent, thin, and without the peculiar taste and odour of the plant, but ge'nerally somewhat tartish and limpid, tho' somewhat obscured and fouled 'by white dreggy matter: and if the head of the still be not tinned, the 'acidity of this last water causes it to dissolve the copper, so as to become 'green, nauseous, emetic, and poisonous to those who use it, especially weak 'persons and young children; as operating both upwards and downwards 'with severe gripings. If such a misfortune should happen, it is remedied 'by drinking plentifully of milk, sweetned with honey, or of the common 'emollient decoctions.

'4. The

‘ 4. The firſt water, above deſcribed, chiefly contains the oil and preſid-
‘ ing ſpirit of the plant, and always ſomewhat ſaline, which in moſt plants
‘ is acid, but in the more pungent antiſcorbutics a volatile alcali: for the
‘ fire, by boiling the ſubject, diſſolves its oil, and reduces it into ſmall
‘ particles, which are carried upwards by the aſſiſtance of the water, along
‘ with thoſe parts of the plant that become volatile with this motion. And
‘ if the veſſels are exactly cloſed, all theſe, being united together, will be
‘ diſcharged without loſs, and without much alteration into the receiver an-
‘ next; for if we may truſt our ſenſes, theſe waters are richly impregnated
‘ with the odour, taſte, and particular virtues of the volatile parts of plants.
‘ Hence, if the botaniſt juſtly aſſigns the virtues of any plant, as they are
‘ contained in that part which is volatile by a boiling heat, the chemiſt can
‘ preſent thoſe virtues ſeparated from the reſt. The former was attempted
‘ by Mr. *Tournefort*, in his book of plants ſpontaneouſly growing about *Pa-*
‘ *ris*, and by Mr. *Ray*, in his book of the native plants of *England*. *Do-*
‘ *donæus* has, perhaps, ſpoke too boldly, and ſometimes raſhly of them all,
‘ eſpecially in the laſt edition of his work, printed at *Antwerp* in 1644.
‘ I have expreſly obſerved, that the firſt of theſe diſtilled waters contains
‘ only the virtues of the plants, reſiding in that part which is volatile with
‘ this heat; becauſe in the whole mixed juice of the plant there is a certain
‘ virtue depending upon a mixture of this firſt water, and the liquor remain-
‘ ing after that is drawn off. The freſh expreſſed juice of recent mint has
‘ certainly many other diſtinct properties than the diſtilled water thereof.
‘ Whence phyſicians are to obſerve, that the virtues of this water, and of
‘ the native juice, are not the ſame, but very different.

‘ 5. The water of the ſecond running wants the volatile part above de-
‘ ſcribed, yet ſcarce brings over the more fixed part of the plant, except
‘ what is ſomewhat acid and vapid. If when this is come off, freſh rain
‘ water be poured upon the remaining plant, and boiled therewith, or
‘ ſtrongly diſtilled, there riſes a more acid water, containing very little of
‘ the particular virtue of the plant; almoſt the ſame kind of acidity appear-
‘ ing to riſe thus from them all at laſt. This I may venture to affirm upon
‘ experience, that the virtue of deſtroying worms, which the more cele-
‘ brated phyſicians have juſtly attributed to certain diſtilled waters, depends
‘ upon this, that the acid of the water of the laſt running diſſolves the
‘ copper, and thus acquires a virtue not its own. This operation, how-
‘ ever, ſhews, that plants contain an acid ſalt ſo volatile, as to riſe and ſe-
‘ parate from the ſubject with 215 degrees of heat. But experience ſhews,
‘ that the water of this ſecond running has ſcarce any other virtue than that
‘ of cooling; as may be ſafely tried by uſing a glaſs ſtill-head inſtead of a
‘ copper one, by which means the inconvenience of its diſſolving the cop-
‘ per is prevented.

‘ 6. And this is the beſt method of preparing the diſtilled officinal waters,
‘ provided the two ſorts be not mixed together, for both of them would
‘ be ſpoiled by ſuch a mixture; they alſo ſpoil with keeping, and will
‘ ſeldom

'feldom remain perfect a year, but degenerate like thofe formerly men-
'tioned (*a*).

The ufe.

We learn from the prefent procefs, (1.) what a plant parts with by the heat of boiling water; *viz.* the water of our firft procefs, the volatile oil with its inherent fpirit, and a faline acid. (2.) What remains in the ftill after the feparation of thefe three parts; *viz.* the extract of our third procefs, together with the preparations it afforded in the fourth, fifth, fixth, feventh, ninth, tenth, eleventh, and twelfth. (3.) In what part the odour and tafte of a plant refide; *viz.* in the water of the firft procefs, in the volatile oil contained in this water, and in the fpirit contained in this oil. (4.) Hence is eafily known what exhales by boiling, both in cookery and pharmacy, and what remains behind. If coftmary, chervil, baulm, or fmallage be boiled in broth, they lofe their peculiar fmell and tafte, with the virtues thereon depending, and only leave behind their common ungrateful parts; but if cut fmall, and added to the foup already prepared, and kept hot, but not boiling, in a veffel clofe covered, fo as to infufe for a while, they communicate their peculiar virtues thereto. Cinnamon affords an extremely grateful water, which furprizingly warms and exhilarates; but when this is all come over, there follows another that is acid and indolent, leaving an acid, auftere, and cooling decoction behind, refembling that of oak-wood. (5.) Hence it plainly appears at what time, with the fame force of fire, quite contrary virtues may arife from a plant; for fo long as a milky water comes over from fuch plants as are aromatic, fo long the water remains warming and attenuating; but when it comes thin and pellucid, it is acid and cooling. (6.) In the laft place, we have hence the true foundation for the conducting of diftillation; for if the operation be ftopt as foon as ever the white water ceafes to run off, the preparation will be valuable and perfect; but if, thro' a defire of encreafing that quantity, more be drawn off, and fo the latter acid part be mixed with the firft running, this fpoils the whole. We fhould here obferve by the way, that the diftilled waters of inodorous plants which have no aromatic fharpnefs, may yet leave very confiderable virtues; though the contrary is generally fuppofed (*b*). And again, that the native virtues of vegetables may thus in fome meafure be changed by the boiling, from what they originally are. The rofemary remaining in our prefent procefs ftill appears green, and preferves its original form; being only deprived of its native fmell and tafte.

(*a*) See procefs 1. nature and ufes.
(*b*) See procefs 1. nature and ufes.

PROCESS

PROCESS XVI.

The common diſtilled water by the alembic, cohobated or returned back upon more of the freſh plant.

THE laſt proceſs has ſhewed what water and fire may ſeparate from a plant in cloſe veſſels, and what is left behind therein; but the preſent proceſs teaches a method of opening plants ſtill farther, and treating them ſo as to obtain diſtilled waters much richer in thoſe virtues of the ſubject, which were mentioned in the former proceſs.

'Take the plant and liquor remaining in the ſtill after the preceding pro-'ceſs, and preſs them ſtrongly in a ſtrainer, that all the decoction may be 'obtained, and with this mix all the water before drawn over. Return this 'mixture into the ſtill, and add to it as much of the ſame recent ſubject as 'was employed before, and if neceſſary, add likewiſe as much water as may 'make up the former proportion to the plant. Now cloſe the veſſels ex-'actly, and digeſt the whole, with 150 degrees of heat, for the ſpace of three 'days and nights, that the herb being ſo long ſteeped in its own liquor, 'may be opened, looſened, and diſpoſed the eaſier to part with its virtues. 'This digeſtion being ſo long continued, is of great ſervice; but if protract-'ed too long, introduces a change tending to putrefaction. Let the water 'now be diſtilled off in the ſame manner as in the foregoing proceſs, only 'proceeding more cautiouſly, and ſomewhat more ſlowly at the firſt; be-'cauſe the liquor in the ſtill being now thicker, more impregnated with 'the plant, and therefore more flatulent, and apt to ſwell upon feeling the 'fire, it eaſily boils over; but after about one half of the expected water 'is come off, the fire may be prudently raiſed. If the rule before laid 'down be obſerved, and the diſtillation be continued ſo long as the firſt 'water deſcribed in our laſt proceſs comes over, and then the operation be 'immediately ſtopped, the water ſo obtained will be whiter, thicker, more 'odorous, ſapid, frothy and turbid, than that of the laſt proceſs. This water 'alſo preſerves its virtue much longer, and contains it in greater perfection 'than that of the laſt proceſs; which ſhews us a way of concentrating the pecu-'liar virtue of plants, ſo far as it reſides in their volatile odorous parts. So 'likewiſe the remaining decoction in this proceſs is much ſtronger than in the 'former; and as the operation may be repeated as often as one pleaſes, both the 'water and the decoction may by ſeveral repetitions at length be made ex-'tremely rich; ſo that by this means excellent medicines are procurable. Thus 'in the year 1730, I diſtilled baulm after this manner fourteen times ſucceſ-'ſively, and found the water at laſt had a balſamic taſte, and the perfect fra-'grance of the plant, ſo as to prove highly refreſhing, even when barely ſmelt 'to, or taſted. And no wonder, ſince the virtue of many large baſkets of 'baulm were here concentrated, and brought within the compaſs of a ſmall 'glaſs; and the remainder alſo at the bottom of the ſtill being inſpiſſated, 'filled but another glaſs, and proved grateful, auſtere, and ſtrengthening; 'ſo that by mixing the two together, the virtues of the plant might be

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'thus highly concentrated, or brought into a very little room. This pro-'cess therefore does not only afford excellent waters, but admirable ex-'tracts also; which, when properly mixed together, yield medicines of such 'efficacy as can scarce otherwise be imitated. For, the native virtues of 'vegetables are little changed in this operation; certainly less than in 'others; tho' it must be allowed, that some alteration is produced by so 'long a continuation of the boiling. But both the odour, taste, and effects 'demonstrate, that the waters, thus prepared, retain, in an high degree, the 'specific virtues of the plant.'

And hence it is certain, that the sought medicinal virtue of truly aromatic vegetables resides in that part of them which rises with the heat of boiling water; and that it is possible by art to concentrate their virtues, so that they shall prove much more effectual than in the state they are naturally afforded. Nor is there any limitation; for by continuing to repeat the operation, the virtues of plants may be thus exalted to any degree the artist shall think proper: which shews the extraordinary power of chemistry.

Paracelsus assures us, he found, by experience, that baulm is possessed of so great a specific virtue, as by insinuating into the humours of the body, to restore a new youthful vigour to the aged, and by this means perfectly cure the gout. And *Isaac Hollandus* avouches the same. Now, if these authors said true, I judged I might, by means of the present process, procure the united virtues of the plant in their utmost strength; and indeed, I have in myself experienced extraordinary effects of the water so prepared, by taking it upon an empty stomach. And certainly, it has scarce its equal in hypochondriacal and hysterical disorders, the *chlorosis*, and palpitation of the heart; as often as these diseases proceed rather from a disorder of the spirits, than any collection of morbific matter; tho' it is indeed expensive. I have reduced dried mint, by three or four cohobations, into a balsamic penetrating liquor, which becomes an incomparable and present remedy for strengthening a weak stomach, and curing vomiting proceeding from a cold viscous phlegm lodged about the mouth thereof; as also in lienteries. The water I have in this manner prepared from lemon-peel has, by its fragrance, its agreeably penetrating and highly aromatic taste and virtue, immediately cured flatulencies, deliquiums, faintings, and irregular motions of the heart, tho' taken in a very small dose. The like water, prepared by repeated cohobations from recent wormwood, has succesfully supplied the want of bile in the body; stimulated all the languid vessels that help in forming the chyle, and killed and expelled worms. The like water from the leaves of savine has given an almost incredible motion to the whole nervous system; so as to prove the most excellent of all the medicines for promoting the exclusion of the fœtus, the discharge of the menses and hæmorrhoides. The cohobated water of rue can never be sufficiently recommended for the cure of the falling sickness, the hysteric passion, for expelling poison, and promoting of sweat and perspiration. I do not here mention the water I have thus made from the berries of the juniper tree, and the leaves of the *arbor vitæ*: both of them succesfully curing the dropsy, as that from camomile flowers cures tertian agues. It were endless to pursue these waters thro' all the variety of subjects: I judge it

manifeft upon the whole, that this is a true and excellent method of obtaining the chemical diftilled waters. Some rules, however, are required for applying thefe two general examples to all forts of herbs, which may require fomething peculiar. Thefe rules are as follow.

(1.) Let the aromatic, balfamic, oleaginous, refinous, gummo-refinous, and ftrong fmelling plants, which long retain their natural fragrance, fuch as *arbor vitæ*, baulm, bays, hyffop, juniper, marjoram, mint, origanum, penyroyal, rofemary, fage, *&c.* be gently dried a little in the fhade; then digeft them, with the quantity of water already mentioned, for feventy hours, in a clofe veffel, with 150 degrees of heat, and afterwards diftil in the method above delivered; and thus they will afford excellent waters.

(2.) When waters are to be drawn from barks, roots, feeds and woods that are very denfe, pondrous, tough and refinous, let them be digefted for three, four, or more weeks, with 96 degrees of heat, in veffels perfectly clofed, with a proper quantity of falt and water to open and prepare them better for diftillation: a confiderable quantity of fea-falt is here added, partly to open the fubject the more, but chiefly to prevent putrefaction, which otherwife would certainly happen in fo long a time, and with fuch a heat as is neceffary in this cafe, and fo deftroy the odour, tafte and virtues required. And thus, for example, may waters be prepared from aloes, box, cedar, guaiacum, juniper, rhodium, and the like woods.

(3.) Thofe plants which diffufe their odour to fome diftance from them, and thus foon lofe it, fhould immediately be diftilled after being gathered in a proper feafon, without any previous digeftion; thus burrage, buglos, jafmin, white lilies, lilies of the valley, rofes, *&c.* are hurt by heat, digeftion, and lying in the air. Some woods alfo are hurt in the fame manner; thus the fhavings of faffafras, by being boiled in water, foon lofe their virtue, tafte and fmell.

(4.) The aftringent, nutrimental, healing, confolidating, emollient, farinaceous, gelatinous, cooling and ftyptic virtues of plants are never, by this means, communicated to the diftilled waters; but are to be fought either in the whole plant, or its more fixed part. Whence pharmacy fhould be relieved from the unneceffary trouble of preparing fuch waters; and on the other hand, phyficians are diligently to be admonifhed to feek for fuch virtues in the infufions, decoctions, and extracts of fuch plants. Would it not be ridiculous to expect any thing nutrimental in the indolent and vapid diftilled water of barley, or minced capon's flefh? Can any man expect to find the excellent virtues of forrel, in hot, lax, putrid, and bilious conftitutions, from the diftilled water of this plant? So again it were abfurd to attribute the inimitable virtues of plantain to its diftilled water. Such idle and childifh trifles are therefore to be rejected in the ferious arts of chemiftry and medicine.

(5.) The cafe is far otherwife in thofe plants, whofe real virtue entirely refides in that part which is feparable by a heat not exceeding 214 degrees; for the waters carefully prepared from thefe will contain all the virtue which is left in their decoctions and extracts. The celebrated virtues of lavender flowers, lilies of the valley, and of rue, againft that fpecies of the

falling-

falling-ficknefs which proceeds from a difturbance in the motion of the nervous fluid, refide in the diftilled water, but is abfolutely wanting to the decoctions or extracts; fo on the other hand, the anti-epiletic virtue of piony remains in the decoction, but is wanting in the water.

(6.) There are fome medicinal plants whofe virtues refide in a part which is volatil, with the aforefaid degree of heat, but fo that after thefe are raifed by diftillation, the remaining plant and its decoction continue poffeffed of other virtues, and proper for medicinal ufe. Such decoctions therefore are not to be thrown away, but to be infpiffated with a moderate heat, that they may be kept uncorrupted; for, being afterwards mixed with the diftilled water, the virtues of both are thus united, and afford the whole efficacy of the plant. And of this kind are camomile, carduus benedictus, the leffer centaury, germander, ground-pine, mugwort, rofemary, fage, fcordium, wormwood, *&c.* This tribe of herbs, indeed, are exalted by fermentation, fo as to afford the better waters; but when their decoctions come afterwards to be infpiffated, they either have lefs, or a different kind of virtue from the natural.

(7.) Acid, bitter, auftere, fweet and flat taftes, rarely afcend from plants in diftillation, but commonly remain in their extracts, tho' they afcend from camomile, wormwood, and a few more; but the colour of plants is fcarce ever raifed by diftillation, tho' we have a blue colour in the diftillation of camomile, and a green one in that of wormwood; but thefe colours are rather in the oil than in the waters. The faponaceous virtue, confifting in the union of the falt and oil, never rifes, but remains in the extracts; and therefore plants endowed with this virtue are not to be thus diftilled (*a*).

(8.) The following vegetables fcarce afford any thing of ufe in their diftilled waters; *viz.* barberry, beet, cherries, colewort, currants, elder-berries, endive, ripe grapes, ladies-mantle, lettice, the juices of citrons, lemons, oranges, purflain, fcorzonera, forrel, ftrawberries, and fuccory. There are alfo very contrary virtues in the fame plant: thus the diftilled water of cinnamon, of the firft running, is deobftruent, heating, enlivening, ftimulating, and good in vomiting; but that of the fecond running aftringent, cooling and naufeous; whilft the decoction remaining in the ftill is of a dark red colour, opake, thick, of an auftere tafte, aftringent, coagulating, and ftrengthning.

PROCESS XVII.

The common diftilled water of a recent fermented plant, in the manner of Ludovicus; *by an example in rofemary.*

THE effects of diftillation, digeftion, and cohobation, have fufficiently fhewn us the action of the fire, limited by the degree of boiling water, in diftillation and cohobation; and of a more gentle fire, with water, by digeftion. We now proceed to exhibit an elegant and ufeful way of obtaining the medicinal virtues of plants, very little altered from what they naturally are, tho' rendered more penetrating and more volatile.

(*a*) See the catalogue of plants in the fecond procefs.

‘ 1. Take recent rofemary, with the conditions expreffed in our firft, fif-
‘ teenth, and fixteenth proceffes, cut and bruife it, if that feems neceffary ;
‘ put it into a large oak cafk, leaving a fpace empty at the top four inches
‘ deep ; then take as much water as would, when added, fill the cafk to the
‘ fame height, including the plant, and mix therein about an eighth part
‘ of honey if it be cold winter weather, or a twelfth part if it be warm ;
‘ in the fummer the like quantity of coarfe unrefined fugar might, to the
‘ fame purpofe, be added inftead of the honey ; or half an ounce of yeaft
‘ added for each pint of water will have the effect ; but I prefer the honey,
‘ ufed as defcribed : let the proper quantity therefore of honey and water be
‘ warmed and poured upon the plant in the cafk ; let the cafk ftand up-
‘ right, and have its wide upper orifice, or bung-hole, loofely covered with
‘ a wooden cover ; then fet it in a wooden cheft, to be kept heated by means
‘ of a live coal, buried under light afhes, fo that the liquor and plant may feel
‘ a heat of about eighty degrees, which is afterwards to be conftantly kept
‘ up by covering the outfide with clothes, and a due regulation of the fire,
‘ which muft therefore be greater and more carefully attended in cold wea-
‘ ther ; but in the heat of fummer little or no fire is required. On the fe-
‘ cond day, a hiffing noife will begin in the liquor, with bubbles, frothing,
‘ and a grateful fmell of rofemary ; the plant now again rifing to the fur-
‘ face : this motion is called fermentation. (2.) When this fermentation
‘ has continued fo long, that the plant which was on the top begins to
‘ fubfide and fink to the bottom, the operation is continued long enough
‘ for our purpofe, fo that now the veffel muft be cooled and clofely bunged
‘ down ; for if it fhould continue longer open in the fame warmth, the fpirit
‘ and oil, now rendered more volatile, would fly off, and the virtues re-
‘ quired be loft ; fo that the matter fhould be now directly diftilled. (3).
‘ Take therefore as much of this plant and its fermented liquor as may fill
‘ two thirds of a ftill, and work carefully from the firft : for the liquor,
‘ containing much fermenting fpirit, eafily rarifies with the fire, froths, fwells,
‘ and hence becomes very apt to boil over. And as all this happens much
‘ quicker in this diftillation than in the foregoing kinds, we ought here to
‘ work flower, efpecially at the firft. (4.) And thus there will come over
‘ firft a limpid, unctuous, penetrating, odorous, fapid, liquor, all which is to
‘ be kept feparate ; there follows a milky, opake, turbid liquor, ftill contain-
‘ ing fomething of the fame tafte and odour ; and at length comes one that
‘ is thin, acid, not fragrant, and fcarce having any property of the rofe-
‘ mary. There remains in the ftill an extract, indolent with refpect to the
‘ rofemary, and retaining moft of the fubftance of the honey. And all thefe
‘ particulars hold, when the fermentation is continued till the plant fponta-
‘ neoufly falls to the bottom of the cafk ; which, with the abovementioned
‘ degree of heat, ufually happens in five or fix days. (5.) This firft water,
‘ or rather fpirit, may be kept for feveral years, in a clofe veffel, without
‘ changing or growing ropy. It alfo excellently retains the tafte and odour
‘ of the plant, tho' a little altered ; but if lefs honey were added, lefs heat
‘ employed, or the fermentation continued only two or three days ; then the
‘ diftilled water of the firft running would be white, thick, opake, unctu-
‘ ous

'ous, frothy, and perfectly retain the ſcent and taſte of the plant, or much 'leſs altered than in the former caſe; tho' the water will not be ſo ſharp 'and penetrating. After this is drawn off, a tartiſh, limpid, inodorous 'liquor will riſe, leaving a remainder behind, that retains much leſs of the 'properties of roſemary, than in the preceding proceſs.'

2. There is alſo in this caſe always found ſome oil in the firſt water, which was not in the former ſpirit. Again, if the fermentation were to continue only for a day, or a day and an half, the water that firſt comes over would largely abound with oil. In other reſpects matters are nearly the ſame in both; for it is conſtantly found, that the longer the fermentation was continued, the leſs oil appears in the diſtilled water, and therefore what runs firſt is always clearer and ſtronger; but upon mixing with common water, the whole immediately becomes milky; whence theſe waters greatly differ from one another, according as they are differently prepared in the abovementioned reſpects. When the fermentation is perfectly performed, the firſt water will be limpid, the ſecond milky, and if a third be forced over by a ſtrong boiling heat long continued, it will prove acid, thin, and limpid, reſembling diſtilled vinegar. The extract in this caſe will always be the leſs impregnated with the virtue of the plant employed, the longer the fermentation was continued, or the more perfectly it was performed, and *vice verſâ*; the oil alſo, which in the fifteenth and ſixteenth proceſſes floated upon the ſurface of the water, becomes ſo attenuated when the plant is perfectly fermented before diſtillation, as entirely to diſappear and lye concealed, or ſubtilly divided in the diſtilled liquor; which may therefore be called ſpirit, rather than water. That this is the caſe appears from hence, that if a large quantity of water be added to the ſpirit, it preſently grows white; which ſhews that there was oil concealed in it: nay, frequently, little drops of oil, thus regenerated, will float upon the ſurface of the water.

The uſe.

1. Hence we learn that this fermentation (when perfectly finiſhed in the proper time required for that purpoſe, with a large proportion of ferment, and if the whole fermented matter be for ſome time contained cloſely bunged down in a caſk) affords theſe waters extremely limpid, hot, aromatic, odorous, ſapid, and penetrating, without any ſign of their containing an oil; and according as theſe properties appear more in the water, the native virtues of the plant are more changed; ſo that at laſt they can ſcarce be known; but when the fermentation is perfect, each loſing its proper character, they all become nearly alike: whence it is manifeſt that the particular virtues of vegetables are not exalted or perfected by fermentation; as they were in the preceding proceſs by repeated cohobation; and that the waters by ſuch cohobation are not rendered ſo ſpirituous, as by a ſingle fermentation. And this ſeems to proceed from hence, that in the long continued and active motion of fermentation, the volatile preſiding ſpirit, now freed from the opened parts of the plant, but principally from the attenuated oil, exhales; for the tenacity of the oil was the chief thing that detained and locked the ſpirit in the plant. But a gentle and moderate fermentation, which does not diſſipate the ſpirit,

ſpirit, only diſſolves the viſcous obſtacles, admirably quickens theſe waters, makes them durable, or long preſerves them from corruption, dregginefs and ropineſs; as is excellently obſerved by that ſkilful and candid chemiſt *Daniel Ludovicus*, in his diſpenſatory accommodated to the preſent age. And thus the water of *carduus benedictus*, ſo prepared, is highly commended, where ſweating and perſpiration are required.

2. Hence the taſte and ſmell of plants, communicated to their diſtilled waters, principally depend upon their native ſpirit reſpectively. But as this ſpirit is wrapped up in a tenacious oil, when this oil is mixed with the waters it renders them the more odorous and ſapid, in the larger quantity it is ſo mixed. This oil is gradually thinned, made leſs tenacious, more ſpirituous, and eaſier to mix with water, by diſtillation, digeſtion, and cohobation in cloſe veſſels; but thus the ſpirit alſo becomes more volatile and diſintangled, ſo as eaſily to fly off, unleſs it is every way very cloſely confined in the veſſels during the diſtillation; which being performed, highly efficacious waters may be thus prepared. But as fermentation requires a length of time, the admiſſion of the air, and open veſſels, it attenuates oils by its motion, ſo as to mix them with water, and in this form make an inflammable liquor; which cannot happen without a diſſipation of the native ſpirit. It however renders oils miſcible with the animal juices, and fit to enter the fineſt veſſels; but always deſtroys the peculiar virtue of the plant: in the mean time, it proves the medium of conveying ſtimulating and grateful virtues to the nerves; eſpecially thoſe of the noſe, mouth, jaws, throat, ſtomach, and inteſtines.

PROCESS XVIII.

The common diſtilled water per deſcenſum, *from a recent plant*; *by an example in roſemary.*

CHEMISTS formerly called that motion of bodies diſtillation, when, by the aſſiſtance of fire, the ſubject to be changed, and contained in one veſſel to which the fire was applied, paſſes into another joined thereto, whether ſolids were thus treated or fluids; and this operation with them differed in three reſpects. For, (1.) the fire raiſed the matter perpendicularly upwards. (2.) Somewhat obliquely, or laterally, as in diſtillation by the retort. And, (3.) downwards; the fire being applied above: which laſt ſpecies of diſtillation they called diſtillation *per deſcenſum*, which they uſed in the laſt age for ſeparating quickſilver from its ore; and which *Paracelſus* from thence transferred to vegetables. Of this kind of diſtillation we are now to give an example.

‘ 1. Let there be procured a ſufficiently wide, and deep cylindrical ‘ veſſel, made of ſuch matter as will neither tranſmit, drink up, or foul ‘ liquors. From the upper rim of this veſſel cut an inſide groove, fit to re- ‘ ceive exactly, and ſuſtain a round plate ſtruck full of holes; which is to ſink ‘ into the open mouth of the veſſel, ſo far, that the upper ſurface of the ‘ plate be two inches from the rim thereof; then place any recent, green, ſuc-

‘ culent

'culent plant firſt cut or bruiſed, upon the plate, ſo that it may reach up 'to the rim; then apply a flat cover, which may exactly cloſe the mouth of 'the veſſel, with the aſſiſtance of luting to prevent any vapour from ex-'haling (*a*). The whole apparatus may be made of iron-plate, if a large 'quantity of water is required at once; otherwiſe, for a ſingle experiment 'one of earth may ſuffice. Let a little fine aſhes be ſifted upon the cover, 'and a few live coals be placed thereon, that the moiſt parts of the plant may 'be reſolved into vapour; and its juices be liquified ſo as to fall into the 'wide part of the veſſel below; where being condenſed by the cold, they 'will gradually diſtil, and collect; if the fire be prudently managed and 'encreaſed by degrees. And thus the ſpirit, water, wax, gum, oil, roſin, 'as alſo the ſaline and ſaponaceous matter of vegetables, which do not eaſily 'riſe in the preceding diſtillations, may be obtained. Care, however, muſt 'be had not to make the fire too large, for fear of quite burning up the 'parts of the ſubject, tho' indeed a ſmall degree will have but little effect; 'but if a violent fire be uſed, all the parts will be confounded together, 'the oily matter burnt up, the ſmell and taſte of the produce become em-'pyreumatical, ſmoky, bitter, and nauſeous, ſo as to be ſcarce fit for inter-'nal uſe, eſpecially if the ſubject were dry and unctuous. But when ſuc-'culent vegetables are employed, ſuch as roſe-flowers, and prudently treated 'without burning; the water ſo prepared will nearly reſemble the natural 'juices, as containing both their ſaponaceous nature, and peculiar virtues, 'tho' always a little changed by the fire; whence the expreſſed juices them-'ſelves are not only more agreeable, but more medicinal. *Paracelſus*, how-'ever, by treating guaiacum in this manner, obtained an acid liqour, and 'a ſharp fœtid oil, which he recommends both for external and internal 'uſes; whence this operation has been for ſome time practiſed in *Germany*, 'but is now almoſt diſuſed, or changed for others more ſuitable.

PROCESS XIX.

Saline aſhes extracted from the calcined remains of the fifteenth, ſixteenth, ſeventeenth, and eighteenth proceſſes; as in the fifth, ſixth, ninth, tenth, and eleventh.

' 1. IF the remains of the fifteenth proceſs, that is, both the plant and 'the liquor left after the diſtillation, be put into an iron veſſel, and 'evaporated or dried, then committed to an iron pan, and burnt to white 'aſhes over a naked fire, as in the ſixth proceſs, a large quantity of ſalt 'may be afterwards extracted from theſe aſhes, or the ſame which the crude 'plant would have afforded, if burnt before it was diſtilled; for both the 'aſhes and the ſalt here produced are perfectly the ſame as in that caſe: 'or if the decoction remaining in the ſtill be taken ſeparate, or, with the 'addition of all the liquor which the boiled plant affords by expreſſion; and 'a ſalt made thereof, as in the fifth proceſs, thus likewiſe the ſame aſhes 'and the ſame ſalt will be obtained, nearly in the ſame quantity, as

(*a*) See *Libavius*.

'in that procefs: this diftillation therefore does not diminifh the matter of 'the falt.

'2. If the remains of the fixteenth procefs be treated in the fame man-'ner as the preceding; or if only the decoction, or the decoction with the 'plant be employed; the afhes hence obtained will be twice as faline as the 'precedent, but the falt the fame tho' in double the quantity. And when, 'as we inftanced in the cohobation of baulm, the operation is fixteen times 'repeated, the decoction will then afford fixteen times more falt; whence 'it appears, that the decoction upon cohobation encreafes in its faline fapo-'naceous virtue, as the cohobated water does in its volatile fpirituous and 'oily part; whence we are furnifhed with a method of exalting the pecu-'liar virtues of plants at pleafure: and hence art, in a very extraordinary 'inftance, may certainly excel and improve upon nature. And at the fame 'time, cohobation will not diminifh the matter of the falt in the more fixed 'part, tho' ever fo often repeated; provided all putrefaction be prevented 'in the plant.

'3. But when plants are fermented without fugar or honey, and then 'diftilled according to the feventeenth procefs; and the remains come to be 'calcined after our prefent method, we fhall here again obtain almoft the 'fame quantity of the fame falt: whence it appears that fermentation, fo 'performed, does not volatilize that matter in vegetables which affords this 'falt upon calcination. This might appear ftrange, if we had not before 'found that the tartar of the moft perfectly fermented and fubtile wine did 'not afford a large quantity of fixed falt upon burning. But when the 'rofemary is fermented along with honey, and the remainder is afterwards 'reduced to afhes, thefe afhes will have but little fharpnefs, nor eafily afford 'an alcaline falt; for a coal made from honey can fcarce by the fire be 'rendered faline; but remains fomewhat fungous therein, without growing 'fharp. And the remains of the eighteenth procefs afford the lefs falt by 'burning, the more faponaceous and faline matter came over in the water; 'but if very little of this water was afforded, then nearly the fame falt will 'be obtained.'

The ufe.

1. If all thefe particulars are well underftood, we may hence learn the true effects of thefe different diftillations. And, (1.) they feparate the fimple elementary water of vegetables. (2.) The fpirit contained in this water, as defcribed in our third procefs. (3.) The volatile oil or fulphur, which when mixed with the water turns it white; but when collected feparate, refufes to mix with water, or gradually difintangles itfelf from it. In this oil the native fpirit principally refides, communicating the fmell, tafte, and often the particular virtues of the plant thereto. This oil is what I ufually call oil of the firft order in plants; being eafily and firft of all feparable from them, as flightly mixed in with their juices, but not ftrongly fixed thereto; nor greatly adhering to their folid parts, nor much intangled therewith, but often lodged in particular veffels in many fubjects: and when thefe three are feparated from a plant, it afterwards fcarce retains any thing of its priftine tafte and odour.

odour. (4.) By this means alſo there is ſeparated a certain thin, volatile, acid liquor, which, being ſubtilly ſaline, is not fixed but flies off in the burning, and may therefore be properly called the natural vinegar of the plant. This comes over along with the laſt water in the diſtillation of cloves and cinnamon, and even any other the hotteſt vegetables, after the three former matters are entirely ſeparated.

In that part of the plant which, not being volatile in diſtillation, remains behind, we find, (1.) a more fixed oil more intricately mixed in the remaining fixed liquor, ſo that it cannot be raiſed in diſtillation, but remains firmly connected with the proper ſalt of the plant, ſo as to form a ſoap; and a large part of this oil is by the force of a naked fire intimately mixed in among the ſalt of the plant, ſo as thus to form the fixed alcali: yet this oil, ſtill adhering to its own ſalt, may be extracted from the plant by boiling in water (*a*). (2.) The oil which is intimately fixed in the elementary earth, and joins the ſolid frame of the plant together, and which cannot be thence ſeparated by the force of boiling water (*b*). (3.) A very large part of the proper native ſalt of the plant. (4.) That matter of the plant which is afterwards fixed, and changed into a fixed alcaline ſalt, by the action of a violent open fire. (5.) Laſtly, a large part of the elementary earth which goes to conſtitute both the fluids and ſolids; we ſay, a large part only, becauſe much earth is extracted even from the volatile oils of plants.

PROCESS XX.

The native oil of vegetables by expreſſion; ſhewn in almonds.

THERE is a certain part in plants, which being either ſpontaneouſly fluid, or eaſily made ſo by a gentle heat, is called their oil. This oil may become thick by long ſtanding, as we ſee in the oil of turpentine, which, tho' extremely fluid at firſt, manifeſtly thickens by degrees. It may alſo grow thick with cold, and thus appear knotty like fiſh-ſpawn; nay, it may even become ſolid, as we ſee in wax; but by what means ſoever it thus becomes hard, it flows again upon being applied to the fire. This oil, therefore, whenever it becomes liquid, is at the ſame time unctuous, or exceeding ſoft and ſlippery to the touch; tho' it has at the ſame time a certain tenacity or viſcoſity in its parts, not found in waters and ſpirits. Again, theſe oils are always inflammable, and feed both fire and flame, being themſelves diſpoſed to go into flame; a property not found in air, water, or earth: laſtly, oil will not intimately mix with water, but when ſhook therein repels the water from it, collects together, and ſeparates into a diſtinct liquor; in which reſpect it differs from ſpirits. Vegetable oil, therefore, is an unctuous inflammable liquor, that does not mix with water.

This oil is found of many different kinds in plants; the volatile ſort which we have ſeen produced in the diſtillation of the waters from unctuous vegetables, lodges the preſiding ſpirit, which contains the taſte and ſmell of the

(*a*) See proceſs, 3, and 5. (*b*) See proceſs, 3, 4.

plant; whence in this oil the particular fenfible properties of the plant manifeftly refide; which, being once feparated, robs the plant of its nature. Thus, if all this oil were totally extracted from cinnamon, mace, cloves or nutmeg, thefe bodies would remain of their priftine form, fo as to be perfectly knowable, tho' they retain nothing of their peculiar properties. For when all this oil is taken away, thofe fpices can no longer be diftinguifhed by the fmell or tafte; tho' the body of the oil receives not its fmell and tafte from itfelf, but entirely from that fpirit, which, when prefent, diftinguifhes thefe oils, and, when abfent, leaves them fcarce diftinguifhable, and almoft of one and the fame nature.

Sometimes in certain plants, and particular parts thereof, this oil is collected pure, in little peculiar cells or receptacles; at other times oily particles are mixed with the juices of plants, and fo difperfed therein as fcarce to appear in the form of oil, but lye concealed in that of foap. But when thefe latent oily particles affociate, or feparate from the reft, they immediately appear in the form of oil. Thus the juices of a plant being extracted with water, infpiffated, made faponaceous, and dried, it is manifeft that they contain oil by their burning (*a*). On the other hand, a pure oil diftils from incifions made in the fir, the pine, and the larch tree. A tranfverfe fection being made into the root of mafter-wort, newly dug up in the winter, we may, by the help of a microfcope, perceive little drops of gold-coloured oil, ouzing out from certain veffels on the furface: and the fame holds true of a nutmeg, or almond, cut with a warm knife. But we find this oil no where more plentifully than in the cotyledons, or feminal lobes of plants; where it defends the tender embryo from the pernicious effects of unfeafonable water, or too great cold; for freezing might probably prove deftructive to fo fine a ftructure. This oil, likewife, is in the winter-time found driven towards the bark, by the preceding fummer; and being there more drained from its watery moifture, is collected in great abundance, efpecially in the ever-greens. The oil of vegetables, therefore, chiefly abounds in their more durable parts, in order to defend the other natural and more neceffary ones, and is therefore found in fuch parts, as are fartheft removed from the abforbing veffels of the roots, and the nutrimental juice there drawn in from the earth; and thus, more oil is found in ripe linfeed, than perhaps in all the other parts of the plant together. Sometimes, alfo, this oil is collected in fuch quantity as fpontaneoufly to appear in its proper form, burft its cells, and run out; whence the barks of trees and fruits principally afford it, as we fee in pine-apples, juniper-berries, *&c.* efpecially in the ever-greens, where the outward bark is often cafed over with this oil. The trees in the northern regions, which grow upon the high mountains, expofed to the freezing cold, more particularly afford it; whence it fhould feem that this oil is highly requifite to defend the life of vegetables, againft the freezing cold of winter. We likewife obferve that thefe fat oils chiefly grow and collect in full-grown plants, that foon after feem as it were to fleep, or become aged; for both herbs and trees contain little oil in their young growing ftate, but are diftended with a dilute,

(*a*) See procefs 3, and 5.

thin,

thin, watery juice. Thus flax, ſoon after it is firſt ſown, riſes in the form of graſs, and is merely aqueous; but when come to maturity, it loſes its greenneſs, grows yellow, and now affords a copious oil, eſpecially in its ſeed: and the ſame holds true of a young pine, compared with one that is full grown. It is alſo obſerved, that the ſhrubby plants, which have lively roots, gradually contract themſelves upon the approach of winter, with-hold their juices, perſpire but little, receive little nouriſhment from the earth, nor throw much off into the air; and thus they continue to do in a higher degree, as the winter comes on, till at length they in a manner reſt. On the other hand, as the ſpring approaches, all begins to move again, they take in nouriſhment and perſpire. If theſe autumnal or winter ſtations may be called times of ſleep, and the ſummer and vernal periods times of waking, in plants, it will generally appear, that the oils of vegetables are encreaſed in their ſleeping, but their water in their waking. Thus the root of maſter-wort being perfectly leafleſs in the winter, and lying hid and unactive in the earth, may be called dormant; but if now dug up, and examined, it will be found rich in oil; but if again dug up in *May*, it appears aqueous, ſaline, and by no means ſo oily as before: and the ſame is obſerved in trees. Laſtly, we ſee that old trees are oppreſſed with their own oil, and thence ſuffocated, thro' the abundance of fat, as the pine, the fir, *&c*; where this oil appears in the form of a gum, but in others under that of roſin, oil, or balſam. And hence it is that gardners ſo frequently complain of the death of trees, obſtructed in their bark; which thus die, as animals do, when choaked with their own fat.

The chemiſt, therefore, who would extract the oils of vegetables ſhould firſt learn from botany, that there are certain ſeaſons wherein plants abound with water and ſalt, and then but little with oil; and again, that there are other ſeaſons wherein they principally abound with oil, and but little with water and ſalt: for whilſt new leaves, flowers, and fruit are forming in plants, the motion of the aqueous juices, pregnant with ſalt, is promoted, and the ſluggiſh oils excluded; but when the leaves begin to wither and fall off, the flowers to ſhed, or the fruit to ripen, or ſpontaneouſly fall off, when perfect, then the oily parts gradually collect together and preſide; the more ſubtile ones being diſſipated by the ſummer's heat: whence builders fell their timber in the midſt of winter, that it may be durable, and proof againſt moiſture and rottenneſs. For all the hardeſt, moſt ponderous, and laſting woods are found to abound with a ponderous oil; thus cedar and *lignum vitæ* contain an exceeding heavy compact and copious oil. Chemiſts, therefore, muſt chooſe their ſubjects for ſalt at a certain ſeaſon, and for oil at a very different one.

The proceſs.

'1. The ripe ſeeds of moſt vegetables, when they begin to fall and grow 'dry, contain a copious native oil; theſe ſeeds therefore being taken, and 'ſomewhat farther dried, are ground into a kind of meal; but if they prove 'too unctuous for this purpoſe, let them only be bruiſed in a ſtone mortar; 'by which action alone ſome of them will yield an oil; ſuch as almonds, 'pine-nuts, piſtachos, *&c.* Let the meal thus procured be ſuſpended a

'while in the vapour of boiling water, and then again be gently dried to 'open it the more, and fit it the better for yielding its oil by expreffion: 'put this meal or pafte into ftrong hempen bags, which are to be clofe tied 'up, and place them between two iron plates heated in boiling water, and 'fqueeze the bags in a ftrong prefs; and thus the oil being melted by 'this innocent heat, will fweat and drop thro' the bags into a receiving vef- 'fel placed underneath, without *empyreuma*, but almoft as it naturally exifted 'in the plant. And by this means may an oil be drawn from the feeds of 'the leaft oleaginous plants, fuch as hemp, flax, lettice, and numberlefs 'other fubjects; in which no mortal would have expected fuch an oil fhould 'lye concealed. In the fame manner, a copious oil may be expreffed from 'cloves, mace, and nutmegs; tho' the fharp aromatic virtue of thefe 'fpices will not be found in their expreffed oil; for mace and nutmeg, 'when thus treated, rather afford a mild and very thick balfam, than a 'hot aromatic oil, fuch as they yield by diftillation. I was formerly fur- 'prized that the expres'd oil of muftard-feed fhould be ordered with fuc- 'cefs in the raging pain of the ftone, but my wonder ceafed upon finding 'this oil fo fweet, fo foft, and mild; whereas that by diftillation, from the 'fame feed is fo violently fharp and fiery, that to this day I cannot fuffici- 'ently wonder at the difference as often as I confider it; for it feems diffi- 'cult to affign the reafon why this expreffed oil has not the pungent tafte 'and odour, which are fo remarkable in the diftilled oil, and why the 'acrimony of the preceding fpirit, which refides in the oil, is not here ma- 'nifeft: and this whether we regard the water, the falt, the fpirit itfelf, or 'its oil (*a*)'.

2. The oil of our prefent procefs contains very little falt, tho' it has evidently much of the particular nature of the plant, as our fenfes inform us; but whilft frefh, it fheaths, blunts and mollifies what is acrimonious in the humours, relaxes the fibres, membranes, veffels and *vifcera*, when applied thereto, foftens the hardnefs of the flefh, and cures its crifpinefs; it mollifies and moiftens dead and dry efcars, and renders them feparable from the found flefh by the vital actions; it defends the naked parts in wounds, and prevents the dry air from hurting them by deficcation. It alfo prevents the thin humours from exhaling too much thro' the open mouths of the veffels in wounds, and thus fpoiling the extreme veffels; and hence it becomes an excellent remedy for expeditioufly healing recent flefh-wounds. It is alfo accounted a great anodyne, both as it is emollient and relaxing; but thefe oils have one ftrange property, whereby, with the heat only of 70 degrees, they prefently degenerate, without any foreign body being mixed with them, and thus become thin, fharp, bitter, rancid, yellow, corrofive, and inflammatory; whereas they were before thick, mild, fweet, almoft infipid, white, anodyne, and relaxing. And thefe furprizing changes happen in a few days in the fummer's heat. Is it not ftrange that frefh drawn oil of almonds fhould prove healing and fuppling to the parched rough mouth and jaws in the

(*a*) Let the expreffed oils be diftilled, and the remains or preffings; for does not diftillation increafe and raife only the more penetrating, volatile, and pungent oil, and fpirit of plants?

quinfey,

quinſey, and the ſame oil in a few days afterwards ſuddenly inflame the jaws of a perſon in health? And the ſweeter it was when freſh, the ſharper it proves when old and rancid. Hence almonds, walnuts, and piſtachos become exceeding nauſeous, when rancid, and apt to occaſion a ſudden quinſey in the throat, and excite a fever, thro' the burning effect they have upon the mouth, throat, ſtomach, and inteſtines. Phyſicians, therefore, ſhould be cautious, when they order oil of almonds in acute diſtempers, that it be freſh drawn, (from almonds that were not rancid) and, in the heat of ſummer, not kept above twenty-four hours. The ſame thing is alſo found in butter, animal fat, bacon, marrow, and the more perfect oils hereof: all which, tho' innocent when freſh, become highly nauſeous by ſtanding unſalted in a hot air, where they turn yellow, blue, or green, become rank, corroſive, and eaſily poiſonous in the plague. Thus a great acrimony is ſometimes found in cheeſe that has been long kept, whereby I have ſeen the whole mouth violently inflamed. Whence we may eaſily conceive what effects it might have upon the *viſcera*. It is an obvious experiment, that oil, by boiling, will ſoon turn yellow, red, black, bitter, ſharp, and unwholeſome. And this ſhews us how oils may in ſix hours time become extremely bitter in the ſtomach, and, when vomited up, be erroneouſly taken for the bile; for this matter takes flame at the fire. Theſe obſervations upon the nature of oil may lead us to underſtand many particulars in natural, medicinal, pharmaceutical, and culinary hiſtory.

PROCESS XXI.

Native oils, ground with water, and the matters that afford them, make a kind of chyle, milk, or emulſion; by an example in almonds.

' 1. IF the oleaginous ſubſtances, mentioned in the preceding proceſs, being prepared ſo far as is requiſite to afford an oil by expreſſion, ' are ground in a marble mortar with a wooden peſtle, and a little water ' ſlowly and ſucceſſively poured upon them in the grinding, that they may ' thus come into a well wrought paſte, they will change into a white maſs; ' which the longer it is ſo ground, the more uniform it becomes, and the ' better fitted for this proceſs. 2. Then gradually add more fair warm ' water, ſo as to make the whole fluid, and continue the triture without in- ' termiſſion, as before; whereby the liquor floating above the matter, will ' begin to grow milky and unctuous: let the liquor now reſt a little, then ' pour it off by a gentle inclination of the mortar upon a thin linen ſtrainer, ' that the finer part may paſs thro' into a clean veſſel. 3. To the groſs part ' remaining behind in the mortar and in the ſtrainer, again add freſh water, ' and grind and ſtrain as before, adding this ſecond liquor to the former, ' and repeat this for ſeveral times, till the liquor poured off gradually be- ' comes leſs white, leſs thick and unctuous, and at length perfectly aque- ' ous; at which time but a very little of the ſubject will remain in the ' mortar, and that chaffy, poor, exhauſted, and inſoluble in water, tho' aſ- ' ſiſted by long triture; appearing almoſt merely terreſtrial, without ſalt, or

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'the leaft figns of oil: whence by this means the parts of vegetables filled 'with oil are divided into two diftinct kinds; the one diffolvable by water, 'the other not. And it is very remarkable that the fame is performable 'with the mafs remaining in the bags, after the oil was exprefs'd according 'to the laft procefs; excepting only, that fo much the lefs white, thick, unc-'tuous liquor will be afforded, as the more oil was forced out; but even 'after the utmoft violence of the prefs, the remaining matter will ftill yield 'a confiderable quantity of this milky liquor.

The liquor, thus prepared, refembles in many refpects the chyle of animals, which is itfelf prepared from vegetables in their bodies, by chewing, ruminating, and the action of the ftomach, before it is mixed with the bile in the *Duodenum*. The thing appears plain from the white colour, the mild odour, the fweet tafte, the thick unctuoufnefs, and the great difpofition they both have to turn four. So likewife, if the liquor thus prepared ftand fome time in a tall cylindrical veffel, it fpontaneoufly feparates into a white, thick, and almoft totally oily part, which floats at top, and into a thinner, tranfparent, bluifh liquor, that remains below; wherein it perfectly refembles milk, as dividing itfelf into cream and thin milk. Again, if this liqour be kept for fome time, in a warm air, it turns four, and afterwards confiderably fharp, tho' without acquiring the proper rancidnefs of an exprefs'd oil, as defcribed in the laft procefs; in which refpect alfo it perfectly agrees with milk, which acquires the like acidity in fuch an air, without becoming rancid like pure oil: whence this farther remark fhould be made, that in acute diftempers emulfions may be given with greater fafety than expreffed oils. But I could never, by any art of coagulation I have ufed, obtain a curd from this liquor as milk affords; whence there is this difference betwixt the milk of vegetables and animals. The reafon of the difference between the expreffed oil of the preceding, and the emulfion of the prefent procefs, feems chiefly this, that the mealy part in the grinding being conftantly in fine particles interpofed betwixt the pure oil, the parts of this oil are fo broke and feparated from one another, that its tenacity being changed, it becomes mifcible with water, and thence appears in the form of milk, which alfo confifts of a fat fubftance diffolved in water; whereas when a pure oil is obtained by expreffion, the parts thereof, being in contract with each other, do not admit of water, nor fuffer it to be mixed among them. Again, the large quantity of meal, intermixed amongft the oil in the emulfion, caufes it to turn four, not rancid; and hence appears the reafon why the liquor is white; for whitenefs always enfues as often as oil is intimately divided and mixed with water. If oil be poured upon a glafs of water, the two liquors will remain feparate and tranfparent; but if fhook brifkly together, they will unite in fome meafure, and during that union the mixture will appear perfectly white; but if now fuffered to reft, the oil collects at the top, the water finks to the bottom, and the whitenefs immediately vanifhes: and the fame thing frequently happens in animal milk, diftilled oleaginous waters, and thefe emulfions. It is alfo certain, that the whitenefs becomes greater, the larger the quantity of oil; and, in this cafe, the liquor fooner grows rancid; but the lefs the oil, the lefs white the liquor, and the fooner

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it turns ſour. In the ſummer, emulſions will ſcarce keep above ten hours, but in the winter longer. To conclude, this method of making emulſions gives light to the action of maſtication; for all the foods prepared from corn, abounding with a latent oil, and being ground by the teeth in chewing, and mixed with the *ſaliva*, the longer they are thus acted upon in the mouth, the nearer they approach to theſe emulſions, and at length always turn white, when the ſaliva, ſalt and oil are well ground together. The operation thus begun in the mouth is carried on in the ſtomach, and more perfected in the inteſtines, where the matter ſtill retains the ſame nature; except that new juices are perpetually mixing themſelves therewith, and communicating their properties; whereas in our pharmaceutical operation, there is no addition but of water alone. And hence we may underſtand the artificial diſtinction between the firſt chyle, and the milk of animals.

PROCESS XXII.

The native oils of plants, prepared by ſimple boiling with water.

'1. WHEN plants, or their more oily parts, have, according to the '20th proceſs, been deprived of all their oil ſeparable by the 'preſs, let the remainder, included in a linen bag, be kept for a ſufficient 'time in boiling water, whereby the oil left behind, being diſſolved, will 'float on the ſurface, and ſhould now be carefully taken off with a ladle, 'and preſerved together. Let this operation be continued ſo long as any 'oil, or fat ſcum riſes, and thus all the oil left in the ſubject after expreſ-'ſion will appear, which might alſo be obtained in the way of emulſion, 'by the preceding proceſs; and even the water by boiling ſo long will 'acquire a milky colour, and an unctuous conſiſtence, and thus ſhew that 'much oil ſtill remained behind. 2. But if the ſubject were prepared, as 'in the 20th proceſs for obtaining its expreſſed oil, and boiled in water 'after the ſame manner, an incredible quantity of oil may be thus pro-'cured. Thus a pound of the beſt cocoa-nuts being boiled to a pappy 'conſiſtence, with a gallon of water, the fat collected from them, which 'when cold appeared like ſuet, amounted to ſeven ounces (*a*). And ſtill 'what remains after the boiling, being dried, ground, and preſſed, uſually 'affords ſome quantity of oil; of which there therefore ſeems to be a ſur-'prizing proportion in ſeeds. Tho' there are ſome of a poorer kind which 'ſcarce afford any oil by expreſſion or boiling with water; ſuch as beans, 'peas, lentiles, *&c.* yet even theſe being dried, and gently roaſted, afford 'ſome oil in both ways: and what is thus prepared by boiling retains 'much of the particular nature of the plant, not conſiderably changed.'

(*a*) See the experiment as made by Mr. *Homberg* in the hiſtory of the royal academy of *Paris*, by M. *du Hamel*, pag. 371, ed. 1701.

The

The use.

The three preceding experiments being duly made, compared together, and well confidered, fhew, (1.) that the native oil fpontaneoufly refides in plants, as a natural conftituent part thereof. Whence we alfo learn the origin of the fat in animals, which feed upon vegetables; fince vegetables conftantly abound with oil, which may be prepared and extracted from them by chewing, ruminating, and the power which the body has of making the chyle. (2.) We hence fee the nature and ufe of this oil in plants. (3.) So likewife we learn the manner, whereby a liquor, extremely like chyle and milk, may be produced from oil and water mixed and ground together in a certain manner, and hence perceive how the human body acts in producing chyle and milk. (4.) Hereby we are orderly led to confider thofe oils called effential, which will now foon follow. (5.) Phyficians acquainted with thefe particulars will not wonder whence men in health, who ufe little exercife, fhould abound in fat, even tho' they often ufe nothing but vegetable food; fince expreffion and emulfion can fo eafily extract a large quantity of oil from vegetables not apparently oily. (6.) Hence we fee the origin both of chyle and milk; and, (7.) the nature of thofe principles which conftitute them both; *viz.* the animal juices, confifting of the *faliva*, the fine arterious dew, the mucus of the mouth, jaws, gullet, ftomach, and inteftines; and again of thofe aqueous, faponaceous, oily, and fpirituous matters, in the liquors enumerated, which may be brought into the form of an emulfion, and expreffed from the groffer parts, by the means of maftication, deglutition, the action of the ftomach, and the periftaltic motion. (8.) Hence alfo may eafily be derived the phyfical reafon, why the milk of animals, prepared entirely from vegetable and tartifh food, is fo apt to turn four, when out of the body. Recent verdant grafs, by being long mafticated, or ruminated, with a large proportion of *faliva*, begins even in the mouth to affume the form of milk, and promote the production of fat: whence men ufually grow fat with bread and water, and cattle with water and grafs. (9.) After all this, we muft not credit thofe who pretend by art to extract more oil from plants than nature has given them; for we cannot generate oil by art, but only feparate that which before exifted in the plant (*a*). Laftly, thefe oils gained by expreffion, emulfion, and decoction, are not to be efteemed as pure, fimple, and unmixed; for when analyfed by diftillation, in the way hereafter to be mentioned, they refolve into much water, foot, true effential oil, and earth, as that accurate chemift Dr. *Slare* has obferved (*b*). And from hence it feems to proceed, that thefe oils, procured by expreffion, decoction, or trituration, fo eafily change in the air; as confifting of a mixture of fo many different things. The oils prepared by coction contain falt, but not fo much as decoctions made with water.

(*a*) Compare this with procefs 23. pag. 65. and pag. 68. §. 2. and procefs 25. §. 2.
(*b*) See philofophical tranfactions abridg'd by *Lowth*. vol. 3. p. 361.

PROCESS

PROCESS XXIII.

Distilled, or essential oils, by the alembic; from the recent leaves of savine.

ALL plants are more or less fit for this operation, but chiefly those which are rich in an aromatic virtue, such as we described in our first, fifteenth, and sixteenth processes; and none of these are more proper for our present purpose than those of a high and fragrant odour, and a pungent, hot and grateful taste: but in the present process, which opens the subject of essential oils, we are more particularly concerned with the leaves of plants. These leaves are either the recent ones of ever-greens, or the fading ones of plants that shed their leaves.

The aromatic leaves of ever-greens, such as the *arbor vitæ*, bay, box, cedar, citron, ivy, juniper, lemon, *marum syriacum*, myrtle, orange, pine, rosemary, savine, sage, thyme, wild-thyme, are almost always full of oil, but chiefly in the autumn, and towards winter; so that the rule and method of working is nearly the same for them all.

But the annual aromatic leaves which die spontaneously, tho' when green prove highly odoriferous and aromatic, are to be gathered for our present purpose at the time of their full growth, or just before they begin to decline from their utmost vigour; for then the aqueous moisture and the salt being dissipated, leave a more tenacious oil and balsam behind: and the principal plants of this kind we enumerated in the catalogue of our first process. Experience has shewn that these leaves, being gathered at the time above mentioned, afford more oil if they are somewhat dried in the shade, and a moderately fanning air, before distillation, than if they were immediately committed to the still, with a watery juice remaining in them; perhaps, because the water being carried off, the oils unite the closer, and come over in their proper form; whilst being divided by the interposition of the water, they indeed impregnate the distilled liquor with their virtue, tho' they do not appear in the form of oil: but care must be had not to use too great a heat in the drying, lest the oil also should fly off. Some leaves, however, are found to contain so large a quantity of a balsamic oil, as to afford it copiously upon distillation; as we see in mint and rosemary. There are also others that dry with difficulty, and lose of their fine spirit which enriches the oil; such as calamint and maudlin-tansey: so that some particulars are always to be excepted from the general rule.

The Process.

' 1. Take the green leaves, therefore, of any of these plants, which, with-
' out bruising, spontaneously and copiously emit their fragrance; put them
' into a still, whereof they may possess two thirds, and pour on the distilled
' water of the same plant to the same height; then immediately perform
' the distillation; and thus baulm, calamint, dill, dittany, fennel, lovage,

'*marum syriacum*, marjoram, maudlin-tansey, mint, origanum, sage, savine, 'savory, scurvy-grass, southernwood, tansey, thyme, and wild-thyme, all 'immediately afford their oils. But others require to be long digested, in 'a vessel exactly closed, together with sea-salt, or the spirit of vitriol, in 'order to fit them to afford their oil in perfection, and in larger quantity. 'Thus if the essential oils be required from the leaves of bays, box, *calamus* '*aromaticus*, cedar, camomile, citron, fir, hyssop, juniper, lemon, myrtle, 'orange, or pine, let them be first gently dried, then put into a still so as 'to fill two thirds thereof; pour on their own distilled water to the same 'height, and for every pint of the water add half an ounce of sea-salt, or a 'dram of the oil of vitriol; lute the still perfectly close, and continue the 'heat up to 90 degrees, for three weeks, before the distillation: but the 'more tenaciously any leaves retain their oils, the more acid and the longer 'digestion they require; for acids loosen and resolve these oils, and, perhaps, 'in some measure encrease them (*a*), according to the observation of *Boyle*, '*Hoffman*, *Homberg*, and *Le Mort*. Now, therefore, proceed to distillation, 'as in obtaining the water of the fifteenth process, only observing to make 'the matter boil quick, and the still to run strong, for thus the oil required 'will come over with the first water; whereas if the distillation be too slow, 'the oil will be agitated by a great heat; yet not being able to rise, it will 'be mixed in among the water and the leaves, and be thus attenuated, and 'greatly enrich the water, to the diminution of the oil. Let the distillation 'be continued with this degree of heat, so long as any oil comes over with 'the water; the receiver being often changed, to discover how long any 'oil continues to rise: for the distillation should be continued so long as the 'water has any considerable virtues, as mentioned in the fifteenth and six-'teenth processes; for this water is serviceable in procuring new oil.

'2. In this operation, therefore, the cells and skins containing the oil, be-'ing softned by the digestion, and burst by the boiling heat, which sets 'free, moves, and rarifies the oil, this is consequently liquified, and thrown 'to the surface of the water, especially if the plant be *European*. And as 'the oily particles are carried upwards along with the watry, they are to-'gether forced into the worm; where being condensed, by the cold, into 'oil they are thus transmitted into the receiver pure, considerably natural, 'without any *empyreuma*, and excellently retaining, in a small compass, the 'odour, taste, and peculiar virtues of the plant; leaving its remainder per-'fectly deprived of all the oil by the distillation, and almost without any 'mark of its own nature: for the oils of box, calamint, and wormwood, 'are as perfectly distinguishable by their smell and taste, as the plants from 'whence they were drawn, whilst the plants themselves, from whence all 'the oil is extracted, cannot afterwards be well distinguished from each 'other. These oils long retain their virtues without growing rancid, and 'therefore, with respect to all these properties, the chemists have aptly 'termed them *essential oils*.

(*a*) How does this agree with what was delivered under process 22. *The use, ad finem*, &c.

The use.

1. These oils have a certain sharp, heating, inflammatory property, so as to stimulate the nervous fibres, attenuate viscidities, prove grateful to the smell and taste, and quicken the spirits. Their acrimony appears from hence, that if applied to the naked membranes and nerves in wounds, they give an acute pain. We learn they are heating, because, when taken inwardly, they excite a greater heat than almost any other simple body; so that a free use of them will bring on burning fevers, keep them up, and by an encreased and continued use, raise them even to the utmost degree of heat and violence. When externally applied to the skin of an healthy person, so that they cannot be thrown off, they cause an heat, burning, pain, redness, shining, pulsation, and blisters; and if their action be great, even gangrenes: whence it is manifest how high an inflammatory power they have, when imprudently given internally, where coming in contact with the *viscera* and membranes, they may produce the like inflammations, and hence being actuated in the body by the force of circulation, they effectually stimulate the nerves, and may thus excellently attenuate, and intimately divide those viscidities, which, arising from mere inactivity, require to be resolved by a brisker motion. Again, the odoriferous kind, by their sweetness and pleasant taste, prove highly acceptable and refreshing in faintness and torpidity; and all these effects they have not by means of their oily tenacity, but of the subtile spirits, which are lodged in this oil, and contain the proper taste and smell of the plant, according to what we have already often mentioned (*a*). These oils, therefore, by a prudent medicinal use, afford the noblest remedies against all those distempers wherein the animal, natural, and vital spirits are wanting, or torpid: for instance, in persons afflicted with cold watery disorders, a simple leucophlegmatia, or mucous serosity, proceeding from mere inactivity, without any inflammatory obstruction. Hence also they become serviceable in winter fevers, that are perfectly intermittent, and attended with cold fits; being given whilst the fever is off, and chiefly before the cold fit is expected. A moderate use of them also is serviceable to aged persons, and to the hypochondriacal, whose blood is sluggish and unfit for affording of spirits; whence such persons become indolent, forgetful, heavy, lethargic, and apt to weep like children. In like manner they are serviceable to hysterical women; but where hysterical disorders proceed from a *plethora*, essential oils, tho' in other cases so excellent, prove very prejudicial; and the like is to be understood of apoplectic cases: for tho' these oils are serviceable where the patient is old, and lethargic thro' a want of spirits and activity; yet they prove almost mortal when the disorder proceeds from blood extravasated within the skull, or from an inflammatory fulness or *plethora*: whence such persons have been often hurt by the use of apoplectic balsams, prepared from these oils, tho' almost every where indiscriminately commended. They are in no distempers more de-

(*a*) See process 1, 15, 16, 17.

ſervedly praiſed than againſt flatulencies in the ſtomach, gripings, and the colic; but here alſo they muſt be prudently uſed, becauſe theſe diſorders may ariſe from inflammation, ſpaſms occaſioned by fulneſs, and the like cauſes, wherein ſuch oils are hurtful; tho', on the other hand, excellent, when thoſe diſorders proceed from mere coldneſs, languid circulation, and a cold viſcid ſeroſity blocking up the inteſtines.

2. With regard to the chemical uſe of our preſent proceſs, it is hence manifeſt, (1.) that aromatic plants contain an oil which is volatile with the heat of boiling water; (2.) That this oil principally contains the preſiding ſpirit, which riſes together with it, and after diſtillation remains for ſeveral years therein, provided the containing veſſel be cloſe ſtopped; (3.) That plants contain this oil only in one certain quantity, which being drawn out, there remains no more behind; (4.) But if the boiling water in this diſtillation be ſaturated with as much ſalt as it can diſſolve, it will then be hotter than mere water, as was ſhewn in the theoretical part; whence by means of a large quantity of ſalt, more eſſential oil may be extracted from a vegetable than by boiling water alone, without it; but it is erroneous to expect by this means more of the ſpirit wherein the virtue of the oil reſides, for the native ſpirit is ſeparable by the boiling heat of mere water; ſo that the promiſes made upon this head are vain (*a*). (5.) Hence we learn, alſo, that theſe oils are more volatile than the ſaline matter, which, with a ſtronger fire, riſes in a volatile, oily, acid, or alcaline ſalt, or that which by calcination is changed into fixed alcali. (6.) That the proper virtues of every plant are found more in theſe oils, than in other of their ſimple parts; tho' this always with reſpect to the ſpirit wrapped up in the oil: for neither the water, the fixed oil, the ſaponaceous part, nor the ſalt of the plant contain this peculiar and proper virtue; as by ſeparately examining all the reſt, no one could diſcover from what plant they proceed; whilſt the oil alone, by its ſmell and taſte, never fails to indicate the plant it was drawn from: or if theſe oils ſhould correſpond to two different ſubjects, it is then uſual to give them the ſame name, as in the oil of roſes, and *lignum rhodium*, or roſe-wood. So likewiſe the great agreement betwixt the oil of *caſſia lignea*, and cinnamon, has occaſioned the true cinnamon tree to be called *caſſia lignea*, and the other *caſſia fiſtula*. (7.) Laſtly, we hence learn what an excellent part plants may loſe by boiling.

PROCESS XXIV.

The diſtilled oils from dry leaves, by the alembic; ſhewn in mint.

' 1. WE proceed to ſhew the ſame experiment upon a dry plant. Take ' mint therefore that was gathered in a proper ſeaſon, dried in the ' ſhade, and kept for ſix months; digeſt and diſtil it with its own diſtilled ' water, as in the preceding proceſs, obſerving only not to fill the ſtill above ' half, with the dry leaves; becauſe being thus ſhrunk, they will ſwell very

(*a*) This ſhould be well determined by experiment. It ſeems to be true.

' much

'much with the water poured upon them, and ſo eaſily burn or boil over. 'By this means there will riſe, thro' the whole time of diſtillation, a conſi-'derable quantity of oil, rich in taſte, ſmell and virtue, and floating upon 'the diſtilled water.

'2. If all the liquor be expreſſed from the remainder, and poured upon 'a freſh parcel of mint, and all the former diſtilled water be likewiſe re-'turned after the oil is firſt ſeparated from it, with the addition alſo of as 'much more diſtilled mint-water, as is neceſſary, and the whole be digeſted 'and diſtilled as before; this ſecond operation will afford a much larger 'quantity of oil, and if ſeveral times repeated, the more oil will each time 'be acquired; for by numerous cohobations, the water will become ex-'tremely rich and full of oil. It is manifeſt, that the diſtilled waters here 'retain the peculiar virtues of the plants, as was ſufficiently ſhewn in the 'ſixteenth proceſs. We have alſo ſufficiently explained the uſe of the pre-'ſent under the precedent, or the twenty-third proceſs; to which may like-'wiſe be added what we have before ſaid of procuring oil by cohobation.

PROCESS XXV.

The diſtilled oil of flowers; by an example in lavender.

'THE moſt odoriferous part of plants either reſides entirely, or is found 'in greateſt perfection in their flowers. But as it is here ſweeteſt, 'ſo it is moſt periſhable, by reaſon of the delicacy, unſtable, and falling 'nature of the flowers, tho' indeed there are ſome, as the kinds of laven-'der, which long preſerve their fragrance; but the method of obtaining 'their oil is nearly the ſame in all. For which purpoſe they are to be ga-'thered at that time they are ſweeteſt, which generally happens when their '*Petala* begin to open; let them be gathered whole, with the morning dew 'upon them, and immediately be committed to the ſtill, whereof they may 'poſſeſs two thirds; a ſufficient quantity of the diſtilled water of the ſame 'flower being poured thereon, and as much oil of vitriol as may give a 'grateful acidity to the whole; then immediately diſtil as in the preceding 'proceſs, by which means ſome oil will appear floating on the water, which 'is to be collected and kept apart. Let the decoction be expreſs'd from the 'flowers remaining in the ſtill, and be returned upon a freſh parcel along 'with the former diſtilled water, and a little more oil of vitriol; and thus 'by repeating the operation, a much larger quantity of oil will be now ob-'tained. Repeat the proceſs three times, or more; for the oftner the 'work is repeated, the more oil will each time be obtained; the decoction 'each time growing thicker, and the cohobated water ſtronger, or fuller 'of oil, which is to be carefully ſeparated after every diſtillation. And 'thus the diſtilled waters alſo, ſo often returned, at length become extremely 'fragrant, like the oils themſelves, and rich in medicinal virtue.

‘ 2. As this oil is highly odoriferous, and therefore exceeding valuable, ‘ so it can only be obtained in a very ſmall quantity, whence chemiſts have ‘ uſed great endeavours to find a way of encreaſing it, without impairing its ‘ virtue, and at length obſerved, that if the flowers were digeſted in a cloſe ‘ veſſel for fifteen days or more, with the addition of ſo much oil of vitriol ‘ as might preſerve them from putrefaction, they would afford a third part ‘ more of an excellent oil; as we ſee by an example in the precious oil of ‘ roſes, given in the hiſtory of the royal academy of ſciences at *Paris* (*a*). ‘ Some of the principal flowers that are fit for this purpoſe are the follow- ‘ ing, *viz.* the flowers of camomile, citron, clove, hyacinth, *July*-flowers, ‘ jaſmin, lavender, white lilies, lilies of the valley, lemon, maudlin-tanſey, ‘ orange, *philadelphus athenæi*, roſes and tanſey.

The uſe.

Theſe oils, for their excellent fragrance, are valued by great perſonages, and ſold at a high price; whence it is worth while to ſtudy them.

PROCESS XXVI.

The diſtilled oils of ſeeds; by an example in fennel.

IT has been long obſerved, that the oil of plants is plentifully lodged in the *cotyledons*, or double *placenta* of their ſeeds; whence their oil has been long ſought, eſpecially in the aromatic kinds; and it has appeared that the more ſharp, hot and odorous they were, the more copious and excellent oil they afforded. Yet nature does not conſtantly follow this rule alone; for tho' ſometimes the ſeed contains this aromatic oil, as in aniſe, cummin, *&c.* yet in others the oil is not found in the ſeed, but in different parts: thus the curious oil of the roſe is only found in its flower, and none at all in the ſeed, or fruit. The orange-tree contains an excellent odoriferous oil in its flower, the rind of its fruit, and its leaves; but not the leaſt ſigns of any in its ſeed. The ſeed indeed has an oil of its own, but nothing like that excellent one we ſpeak of. Thus the ſeed of the cinnamon-tree affords none of that admirable oil which ſo richly abounds in its bark, leaves, and wood. Hence no general rule can with certainty be laid down, but recourſe muſt be had to particular experiments for ſure information. The beſt ſeeds therefore for this purpoſe we judge to be thoſe of ammi, amomum, angelica, aniſe, bay, cardamom, both the greater and the leſs, carraway, chervil, coriander, cubeb, cummin, dill, fennel, garlic, hedge-muſtard, ſweet-marjoram, maſter-wort, juniper, lovage, muſtard, onions, origanum, pepper, rocket, rue, ſmallage, ſpignel, ſcurvy-graſs, tanſey, zedoary.

‘ Theſe ſeeds are to be gathered when perfectly ripe, and then to be ‘ dried for three weeks in an open airy place, and afterwards digeſted in a

(*a*) See Vol. II. pag. 208.

cloſe

'close vessel, with hot and salted water, for three days; let them afterwards 'be distilled in the same manner as was directed of waters, only with a 'stronger fire; otherwise the oil will not ascend so well: and here again 'salt water being used instead of common, the oil will be raised the better, 'on account of the greater heat of the liquor, and so become purer.

'2. Some of these seeds contain so copious an oil, that rising collectedly, 'and so running into the worm, it is there suddenly cooled by the water 'of the worm-tub, and thus coagulates into a solid mass, which blocks up 'the whole cavity in one cold part; so that no more liquor being able to 'descend, the vapour of the boiling water, and oil, with a violent force 'throws off the head of the still, which might prove dangerous to the ope-'rator. It is therefore proper to see that the worm, here employed, be suf-'ficiently wide, and not kept too cool; but when the water and the oil 'are observed thus to stop their running, let the head of the still be im-'mediately taken off with care, and boiling water poured into the worm, in 'order to dissolve the oil, and drive it out; after which the distillation may 'again proceed as before. The seeds disposed to afford this coagulating oil 'are chiefly those of anise, bay, cardamom, carraway, fennel and zedo-'ary; the oils whereof somewhat resemble camphire, which melts with 'the heat of distillation, and immediately grows solid in the cold; tho' 'it still continues a pure oil, that in distillation generally blocks up the ves-'sels. And in the hottest countries, aromatic plants are often so far matu-'rated, that their oils thus change to camphire.

The use.

Hence again we learn that a copious oil is lodged in the lobes of seeds, and proves rich in the peculiar spirit of the plant, being here safely treasured up for long preserving the tender embryo, afterwards to shoot out in its proper season. Hence also we see that the vital principle may be long preserved by such a balsam, which seems necessary to prevent its being destroyed by the winter's cold, or lest unseasonable warmth, or moisture, should cause it to shoot before the time, and thus expose it to be easily killed; and hence this oil is principally found in the seeds and roots of vegetables. But as there are many seeds, whose distilled oil has no remarkable smell or taste, whilst residing in the seed; we are hence informed, that the spirits of many vegetables escape the cognizance of our senses, whilst yet they actually distinguish the peculiar properties of plants from each other: whence we are taught to attribute somewhat considerable, but not too much, to the sagacity of our senses. Perhaps, the more volatile the spirituous principle is in the oil of seeds, and of the sharper taste, the less time such seeds will retain their growing faculty: and on the other hand, the less active that spiritual principle is, the longer they will remain fit to propagate their species. Certainly, the fragrant aromatic seeds which have an exceeding pungent taste, soon become effete and barren, as we see in the balsamic umbelliferous kind, and the most odoriferous seeds of the *Indies*, which commonly prove sterile with us in *Europe*; such as cardamom, cubeb, zedoary and ginger; whilst,

whilſt, on the other hand, the ſeeds of *caſſia*, the humble plant, *ſenna* and tamarinds long remain perfect: and the ſame thing is found in the grain kind, which will long preſerve their embryos fit for growing. And here it is highly remarkable, that this oil ſhould continue ſo very long unhurt in dry ſeeds, under the form of oil, ſo as by chemical means to be drawn from thence in full virtue; and yet as ſoon as theſe ſeeds begin to ſwell and ſprout with warm water, they ſhould immediately begin to loſe of their oil, and become diſpoſed to produce ſpirit; whence it ſhould ſeem poſſible that this oil may be ſo changed by the moiſture of the fertilizing earth, the action of the warm atmoſphere, and the ſaponaceous virtue of the juices both of the earth and ſeed, as to be diſſolved, attenuated, and rendred miſcible with water, ſo as to be driven into the tender veſſels of the embryo, thro' the canals of the *radiculæ* planted in the lobes or placenta, and thus feed the tender plant with theſe ſpirits; and by communicating its own particular nature to the nutrimental juices, impregnate the whole, and produce the ſpecies. For ſeeds once moiſtened to ſuch a degree as to give ſigns of vital motion, cannot afterwards be well preſerved fit for propagation.

PROCESS XXVII.

The diſtilled oil of Indian *cloves.*

'THIS *Indian* ſpice is very extraordinary; the greater ſort bears its ſeed ' nearly on the top; and the leſſer, which is without ſeed, is ſo rich ' in a ſharp balſamic oil, that when perfect, and a little heated, it ſponta-' neouſly yields one that is highly odoriferous and corroſive, barely by the ' preſſure of the finger, or the prick of a needle. And it is incredible what ' a large proportion of oil theſe cloves contain, when they firſt come to us ' from the *Indies*, and are taken from the middle of the bags, and imme-' diately examined; ſo that there is ſcarce any thing comparable to them ' in reſpect of aromatic oil. Let a parcel of theſe, therefore, be choſe ' perfect, and commit them entire to twelve times their own weight of ' water, and immediately diſtil them briſkly by the alembic and worm: there ' will come over a milky, thick, turbid water, and at the ſame time a large ' quantity of gold-coloured oil, which falls and collects at the bottom of ' the water. When two thirds of the water at firſt poured on are thus come ' over, change the receiver, and add as much freſh water to the remains as ' came over in diſtillation, and work as before; whereby there will be ob-' tained a water ſomewhat impregnated with the aromatic virtue of the ' cloves. Keep all the odoriferous waters apart, to be uſed inſtead of com-' mon water in future diſtillations of the ſame oil; there will now remain ' at the bottom a brown, thick, ſcentleſs liquor, of an acid and ſomewhat ' auſtere taſte, but without any of the former virtue of the cloves, tho' ' theſe remains of the ſubject ſo far retain their priſtine form and colour, ' as, when half dried, eaſily to paſs upon the unwary for genuine: and ' if mixed with thoſe that have not been robbed of their oil, they again

' acquire

'acquire their natural ſmell and taſte, by attracting the oil of the reſt; ſo 'that they cannot afterwards be diſtinguiſhed from them: in which man- 'ner they are often fraudulently adulterated by certain dealers in ſpice. The 'oil thus diſtilled always appears ſomewhat mucilaginous; if it therefore be 'required purer at the firſt operation, inſtead of common water let ſalt and 'water be employed, and the diſtillation be performed after a previous di- 'geſtion of two or three weeks; but the remainder, in this caſe, cannot 'ſo well be examined.'

The uſe.

This oil is extremely heating, and even cauſtic, and therefore affords a very proper and incomparable remedy in cold conſtitutions, and cold diſeaſes, if prudently uſed. It is alſo a noble medicine for raiſing the languid ſpirits, being uſed either internally, or externally; but it is ſurpriſing that this noble oil ſhould ſo ſoon loſe its ſpirits by ſtanding expoſed in a wide glaſs, in the warm open air, at the ſame time perfuming the place with its odour, and at length changing to an indolent, viſcous, unctuous ſubſtance; whereas the ſpice ſo long retains this ſpirit in the violent heat of the hotteſt country. This oil is alſo heavier than water, ſo as always to ſink to the bottom thereof, and remain in full virtue under it. The like is ſcarce to be found in the oils of *Europe*, being principally obſerved only in the hotteſt parts of *Aſia*, *Africa*, and *America*; and chiefly of the aromatic trees, as clove, cinnamon, *guaiacum*, and ſaſſafras. Yet this oil, tho' it be ſo ponderous, becomes volatile with boiling water, and diſtils along with the vapour thereof. Laſtly, it is remarkable, that the plants abounding with ſo hot an oil, do not appear alcaline in their remains after diſtillation, but acid, auſtere, cold, and conſiderably fixed, as if it were to detain this oil, which of itſelf might prove too volatile.

PROCESS XXVIII.

The diſtilled oil of ſaſſafras-wood.

'1. THE lighter odoriferous oily woods, cut in the winter, and brought 'into ſhavings, whilſt ſound and perfect, being ſtrongly diſtilled with 'twenty times their own quantity of water, afford a milky liquor, and an 'oil; which from the ſaſſafras of *America* is almoſt pellucid, and ſinks to 'the bottom of water, tho' the wood that affords it is conſiderably ſoft, 'light, and almoſt ſpungy. Let the diſtillation be continued ſo long as 'any oil comes over, or the water continues richly milky; and an auſtere 'and acid decoction will remain at the bottom of the ſtill. (2.) If a freſh 'quantity of the ſame ſhavings be diſtilled along with the former decoction 'and the water that firſt came over, more oil will now be obtained, and more 'again at the third or fourth repetition, or cohobation. (3.) And by this 'means we obtain the oil from all the woods that afford it with eaſe, ſuch 'as fir, pine, and ſaſſafras; the two former whereof afford lighter oils, that

 'float

'float on water, but saffafras an heavy one, that finks therein. (4.) But 'the hard and ponderous woods muft be thinner fhaved, and long digefted 'with falt and water before they are diftilled; for by this means thefe alfo 'will afford their oil: of this kind are the *arbor vitæ*, benjamin, box, 'cedar, citron, guaiacum, juniper, lemon, orange, rhodium, favine, fnake-'wood, ftorax, and other balfam trees, as thofe which afford the balfams 'of *Capivi*, *Peru*, *Tolu*, and *Gum elemi*; for the longer thefe woods are di-'gefted in clofe veffels with falt and water, the eafier they afford their effen-'tial oils by diftillation. (5.) Thofe trees are fitteft for this procefs, which 'are fat and yield rofin, balfam, gum, or pitch, efpecially thofe which are 'both ponderous and folid; but thofe which are light, fpungy, and grow 'in watery places, as the alder, the elder, the lime, the poplar, and the 'willow, with the like, are unfit for this operation, as fcarce affording any 'effential oil. (6.) The trees fell'd at the time when their juices are in 'their ftrongeft motion, afford lefs oil, and not fo good; but thofe cut down 'in the midft of a frofty winter afford a larger quantity, and a better oil. 'The wood of young trees, whilft in the vigour of their growth, afford 'lefs than thofe which are old, and paft their growth. The ever-greens 'afford a larger quantity, and a fharper oil, than thofe trees which fhed 'their leaves; whence the reafon is manifeft why ponderous woods of a 'ftrong texture are required in building.'

The ufe.

Hence we may underftand that the ponderofity of woods is principally owing to the ponderous compact oil, which clofely binds the other principles together; tho' we do not mean their effential oil alone, but chiefly that fixed kind remaining after diftillation; of this we have examples in cedar, guaiacum, and juniper wood. And upon the fame caufe depends their durability; for the moft lafting woods are always the moft oily, as appears in box, cedar, oak and olive. Extreme hardnefs alfo depends upon the fame; for fpungy foft woods hold little oil, but box, guaiacum, iron-wood, olive and fnake-wood abound therewith. And hence we underftand the difference of balfam, turpentine, rofin and pitch, as being owing to a longer or fhorter, a greater or a lefs infpiffating heat of the fun. Laftly, we hence underftand the nature of rottennefs in timber, proceeding from the worm which feeds upon the fubtile oil contained in the particular cells thereof; which oil being confumed, the wood afterwards falls into a kind of duft or afhes; or elfe by lying expofed to an air fometimes hot, fometimes moift, fometimes dry, and fometimes cold, the oil is at length confumed, and only a friable earth left behind.

PROCESS XXIX.

The diftilled oil of cinnamon.

WE before obferved that a copious oil is collected in the barks of trees, particularly thofe that are old, and of the ever-green kind, which there appears under the different forms of oil, balfam, camphire, turpentine, gum, tears,

tears, pitch, rosin and gummo-rosin, always containing the native fat of the tree. Hence chemists went upon the distilling of these barks in the same manner as woods, and procured a large proportion of excellent oil from them.

The process.

' 1. Take a quantity of choise and fresh biting cinnamon, break it only ' so little as that it may commodiously be received into the still, and distil ' as in the preceding process; there will first come over a water as white ' as milk, admirably retaining the scent, taste, and grateful virtue of the ' cinnamon; and along with this water comes a gold-coloured oil, which ' sinks to the bottom thereof. Let the distillation be continued so long as ' this oil and milky liquor comes over; but immediately change the receiver ' as soon as, with the same degree of fire, a more transparent water succeeds, ' and continue working till no more oil ascends, and the water comes away ' perfectly pellucid; observing carefully whether it contains any smell, or ' taste of the cinnamon. When it ceases to do this, let all the water of ' the second running, which contains any virtue of the cinnamon, be kept ' separate, and pour fresh water upon the remains in the still; and imme- ' diately, by distilling strongly, there will ascend a light, transparent, thin, ' scentless water, of an acid, cooling taste, which usually preys upon the ' copper of the still-head, and thus becomes green, nauseous, emetic, vitriolic, ' and thence vermifugous; but no longer retains any virtue of the cinnamon, ' and may therefore be thrown away. There now remains in the still a thick- ' ish, turbid, brown-coloured, acid, austere, and astringent decoction; whilst ' the bark itself so perfectly resembles cinnamon, that, without tasting or smel- ' ling it, one might easily mistake it for genuine; especially after having been ' gently dried. And if it be laid for some time among heaps of good cin- ' namon, it will recover its virtue from them, by robbing them of theirs in ' the same proportion. (2.) If the two former waters be carefully separated ' from their oil, and used along with the remaining decoction instead of com- ' mon water, in the distillation of fresh cinnamon, a much larger quantity of ' oil will be obtained, and the water of the first running be now extremely ' strong, white and oily; and by repeating the operation, and each time ' separating the oil, it may thus be obtained excellent, and in any quantity ' at pleasure: but there will constantly come over only one determinate ' quantity both of the oil and rich water, that can by no art be exceeded, ' (3.) But because this oil is so valuable as almost to equal gold in price, ' and yet when distilled in this manner, some dreggy mucilaginous matter ' always adheres thereto, detains it, and prevents a perfect separation; chemists ' have endeavoured after a method to prevent it, and have found that if the ' cinnamon be first digested with salted water, or water rendred very acid ' with oil of vitriol, as we before observed of cloves, then this oil will be ' obtained purer by distillation, and may be more elegantly separated; and ' thus by cohobation with this salted, or acidulated water, and the waters ' before distilled from the cinnamon, the oil may be obtained perfect, and ' the water almost equal to the oil in virtue. (4.) But the body of the cinnamon ' remaining after the operation, as we first described it above, when burnt

'to ashes, in an open fire, affords little or no salt; but the decoction, de-'scribed in the second place, being inspissated, affords a very austere extract; 'which, when burnt according to the fifth process, affords but little salt, 'that contains nothing of the virtues peculiar to cinnamon: so that it is a 'fruitless labour sollicitously to collect such a small quantity of salt, and join 'it with its oil for procuring that extremely dear thing called the essential 'salt of cinnamon.

The use.

The barks of the fir-tree, guaiacum, juniper, pine, savine, and sassafras, are principally adapted to this operation; and something of the like kind may be likewise distilled from cassia, having been first long digested. We learn from this process, thus accurately performed, the vanity of those pretenders to chemistry who boast themselves masters of a particular method of obtaining twice or thrice the quantity of this dear and genuine oil from cinnamon; for there is only one certain quantity thereof elaborated by nature, the whole of which is easily drawn from it in this common manner, nor can a grain more be procured by any art. The spirit contained in this oil is perfectly fiery, and will soon consume the parts of a living human body, like true fire; nor is any thing sharper found in other subjects, as is plain from experiments, whether this oil be externally employed, or used internally; for it immediately heats, stimulates, inflames, and burns to a gangrenous eschar: yet there is nothing in all the *materia medica* found comparable to it for its restorative virtue. And if there be any remedy for the cold mucous serosities of the *uterus*, it is this oil properly applied. This wonderful property has often been observed of it, that if it be genuinely prepared by distillation in the island *Ceylon*, and put up in a large quantity into glasses exactly closed, and preserved for many years in a quiet place, a large part of it is said to be changed into a true salt, soluble in water, and rich in the peculiar virtues of cinnamon; as I have been informed by several credible persons. The excellent Dr. *Slare* says, that one part of this oil kept for twenty years, in a well stopt glass, turned into pure salt (*a*). But this does not happen if the oil be negligently kept in the open air, where it loses its spirit, and leaves an indolent mass behind: whence there appears to reside in this spirit a certain power of producing salt from its own sulphur; which is a thing deserving of observation.

PROCESS XXX.

Oils distilled per descensum; *shewn in cloves.*

HUMAN industry first discovered that plants rich in oil, being agitated by the fire, sweat out their unctuous matter, so that it might be collected; and hence was discovered the art of procuring pitch by the burn-

(*a*) See Philosophical Transact. abr. Vol. III. pag. 362.

ing of fat trees (*a*). After this, the more unctuous feeds being bruifed and expofed to a gentle fire, thus fuffered an oil to run from them, as in the cafe of almonds. At length, by the fame method, the aromatic tribe of plants were in particular made to fweat out their oil; but the oil thus procured, differs entirely in fmell, tafte, and virtues, from that which is thence expreffed according to our twentieth procefs. But we are to give an example of the thing.

'Take therefore the beft cloves bruifed to an unctuous pulp, and fpread 'it a quarter of an inch thick upon a clofe linen, ftretched and tied over 'the wide mouth of a cylindrical glafs veffel, fo that it cannot fall into the 'cavity thereof: and the deeper this glafs, the better it is fitted for the pur'pofe; becaufe a fpacious cavity ferves beft to cool and condenfe the oily 'vapour. Then take a difh made of iron plate, fo hollowed with a flat and 'round rim, that this rim may exactly reft upon that of the cylindrical glafs, 'whilft the protuberant part of the difh falls exactly within the mouth of 'the glafs, the depth of the difh's cavity in the middle, the third of an 'inch. Let this difh be a little fqueezed upon the cloves, fo as to prefs 'them with its convex part, and the linen that fupports them a little within 'the mouth of the glafs; when this is done, fill the cavity of the difh 'with clean afhes, and place a few live coals at the top, the heat whereof 'paffing thro' the afhes will liquify the oil, and agitate the native water of 'the cloves, whereby they will both be refolved into vapour; which com'ing into the cavity below, will be condenfed upon the fides of the cold 'glafs, and fall in drops to the bottom, in the form of a fharp water and 'oil. The fire being thus prudently continued, nearly all the oil will fucccef'fively be driven out; and the work is then finifhed, when no more is 'made to defcend by that degree of heat: but beware of putting on too 'much fire, becaufe this would render the produce empyreumatic. On the 'other hand, if the heat be too gentle, fcarce any thing will be forced out: 'a medium is eafily obtained by beginning with a fmall heat, and rifing by 'degrees. And thus by repeating the operation, any quantity of oil may 'be obtained.'

The ufe.

This experiment fhews the nature and appearance of a proper aromatic oil. The oil fo prepared exactly refembles the diftilled effential kind, both in tafte, fmell, and virtue; fo as fcarce in any refpect to be diftinguifhed from it. It is indeed obtained in a lefs quantity than by diftillation with water; but the remainder may be afterwards employed in diftillation, or to other purpofes, as retaining much of the original virtue. And this method is chiefly of ufe when fuch an oil is immediately required, or when we want to exhibit the experiment. In other cafes, we rather make choice of diftillation: but by the prefent procefs, we can expeditioufly obtain the oil from the rinds of citrons, lemons, and oranges, and from mace, nutmeg, and other very unctuous fubftances. And hence we learn what effect this degree

(*a*) *Vide Actium de Coniferis.*

of

of fire may have upon oils, as they are naturally contained in vegetables, by liquifying and ſeparating them, ſo as to make them ſweat out almoſt ſpontaneouſly: but when the ſubjects are too dry to afford this oil commodiouſly, let them be bruiſed, then put into a linen cloth, and expoſed for ſome time to the vapour of hot water, that thus they may be opened before they are committed to the operation; for then they will afford more water and more oil, and that leſs altered, and with greater eaſe. Theſe oils differ ſurpriſingly from thoſe gained by expreſſion; as being much more aromatic when obtained *per deſcenſum*.

SCHOLIUM.

THIS experimental hiſtory of oils, obtained by chemiſtry from ſpices, particularly in the way of diſtillation, as performed from the twentieth to the thirtieth proceſs, contains many extraordinary and uſeful particulars; the principal whereof we will here briefly enumerate, for the ſervice of chemiſtry, natural philoſophy, and medicine.

1. The entire aromatic virtue of plants is contained in their eſſential oil alone; which being perfectly extracted, the remaining ſubſtance retains not the leaſt ſign thereof.

2. This eſſential oil, again, contains the exceeding ſubtile, volatile, minute, ſharp, and ſcarce ponderable ſpirit, which gives the whole virtue to the oil, and which when ſeparated therefrom, leaves nothing particular in the oil: therefore, in theſe oils, the ſulphur is to be carefully diſtinguiſhed from the ſpirit, or the reſinous part from that which is ſharp and fiery. The ſpirit eaſily exhales, but the ſulphur remains ſluggiſh behind, and gradually thickens, ſooner in the air, and ſlower in a cloſe veſſel, thus becoming, from a liquid oil, a groſs one, then a balſam, then a more thick and tenacious ſubſtance, and at laſt a brittle roſin; from all which ſtates, it is again recoverable by diſtillation into a thin liquid oil. Whence many eminent authors have thought that diſtilled oils are only liquified roſins, and roſins again condenſed oils (*a*). Certainly the ſun thus changes oils in plants; for the cedar, the fir, the larch, and the pine weep by inciſion a liquid and thin oil, which being full of ſpirit is extremely aromatic, as I have often tried to my ſurprize; but when this oil comes upon the bark, it begins, with the heat, gradually to loſe of its ſpirit, grow thick, and become a turpentine, not only of a higher conſiſtence, but leſs rich in ſpirit than before. This turpentine, when more dried by the farther action of the ſun, becomes reſinous, loſing its ſpirit more and more, ſo as at length to prove almoſt inodorous and inſipid. Hence, when it is ſaid, that roſin by being diſtilled with water, again reſolves into an oil, we muſt underſtand it of the ſulphureous part alone; but not of both the ſulphureous and the ſpirituous; for the ſpirit does not return, nor is regenerated, but only the fluidity of oil returns. So likewiſe the aromatic odoriferous tears of benjamin, lacca, maſtich, olibanum, and ſarcocol, loſe much

(*a*) See *Bohn.* diſſ. chem. pag. 29, 319, 326.

of their ſpirit at firſt contained in their fluid oils; whence the more liquid and recent theſe are employed, their medicinal effects are always the greater; as on the other hand, they grow perfectly effete with age, and when, at length, all their ſpirit is gone, the remaining oily matters are ſcarce longer diſtinguiſhable from one another. Hence it ſeems probable, that the bodies of eſſential oils are greatly alike, and that the ſpirits alone make the difference between them. Whether this ſpirit differs with the ſpecific gravity of the oils I leave to farther enquiry. It muſt however be carefully obſerved, that a ſharp taſte and virtue may depend upon the ſalt of a plant, tho' in this caſe, the peculiar characteriſtic is not owing thereto, but to the ſpirit of the oil, as we have already ſhewn above in the hiſtory of the alcaline and native ſalts of plants. Vegetables therefore loſe all that is peculiar to them when their oil is extracted.

3. The more pungent odour vegetables have, the more fiery their ſpirit generally proves; and the more biting when chewed in the mouth, the ſharper the ſpirit of their diſtilled oil. So likewiſe they afford the thicker, ſtronger, and deeper coloured oils, when they are ripeſt and moderately dried; but when diſtilled, whilſt moiſt and recent, they afford leſs of a thinner, more tranſparent, leſs heating, but more odoriferous oil: whence, poſſibly, the ſpirit itſelf may arrive gradually at its greateſt perfection in the plant: this is certain, that the ſmell and taſte, which proceed from the ſpirit, are not the ſtrongeſt, when the plant is young, nor till it has arrived at complete maturity. We muſt alſo obſerve that in certain plants, there ſeems to be more ſpirit contained in leſs oil, than in others, and *vice verſâ*. When a pound of nutmegs afford an ounce of oil, and twenty-five pounds of *calamus aromaticus* afford only an ounce; this ſhews that there is not here the ſame proportion between the quantity of the oil and ſpirit. There alſo predominates a certain peculiar acrimony in the ſpirits that diſtinguiſh oils; this acrimony in the oil of cinnamon burns like fire any part of the body it touches, and can ſcarce be waſhed off under a long time; and there is an exceedingly pungent ſpirit in the oils of ſavory and thyme. Hence, therefore, we find there is a ſtrange diſpoſition in theſe ſpirits, which, tho' upon exhaling from the oil, ſcarce diminiſh the weight thereof, yet deprive it of its virtue, and leave it ungrateful, thick, terebinthinaceous, and at length reſinous. I have ſearched after the weight of theſe ſpirits, but could not diſcover it.

4. Eſſential oils are found of different colours, according to the different plants from whence they were diſtilled. The oil of mint is brown, of lavender yellowiſh, of cinnamon gold-coloured, of wormwood black-green, of camomile and yarrow blue, of anniſeed almoſt white, and of camphire quite white. Whether this difference depends upon the difference of the ſpirits, or the oil, or ſome other third principle, that in ſome caſes riſes in diſtillation, is not certain, and deſerves to be enquired into.

5. Theſe oils are ſometimes extremely liquid, almoſt ſpirituous, or ſcarce having any tenacity, as we ſee in the eſſential oil diſtilled from the rind of *China* oranges, this being one of the moſt fluid liquors: and of this kind is the oil of lavender, and even the ponderous oil of ſaſſafras-wood. On the contrary, the oils of ſome other plants are thick; as that of fennel and roſes; that

that of anifed is ftill thicker; and the thickeft of all is camphire. But the thick diffolve with a gentle heat, the thicker with one a little greater, and the thickeft with a moderate one: whence this proceeds fhould be farther examined.

6. Again, thefe oils differ remarkably in their fpecific gravities; fome being confiderably heavier than water, as the oils of cinnamon, cloves, faffafras, nutmeg, and perhaps of other aromatic plants that grow within the tropicks, where the violent heat of the fun might otherwife prove fcorching to them: for thefe oils in diftillation require a greater fire to raife them, and a fhallower ftill, only one fourth whereof remains empty. Other effential oils are extremely light, as that of lavender, and yet this excefs of weight does not make the oils thicker; for the oil of faffafras, as we juft now obferved, is at once very thin and heavy; whilft camphire is at the fame time extremely thick and light; fo that this muft have fome other caufe. The oil of anifeed will often remain floating in water, and that diftilled from juniper-berries fometimes fubfide.

7. Thefe effential aromatic oils have an almoft inimitable virtue, entirely depending upon the fpirit fo often mentioned, which is fharp, inflammatory, grateful, refrefhing, heating, attenuating, and ftimulating to the animal fpirits, and nervous fibres; and by thefe properties the oils prove ferviceable in cold, aged, watery, and phlegmatic conftitutions; and again, in cold intermittents, moift and cold hypochondriacal and hyfterical cafes, or other difeafes proceeding from cold, acid, or aqueous flatulencies in the inteftines; and when prudently ufed in thefe cafes, they prove generally powerful and fafe medicines; but when indifcreetly applied in diftempers attended with violent heat, motion or inflammations, they prove poifonous. The chemifts have prudently obferved, that thefe oils act by means of their fpirits, which, as lodged in the oil, come to be applied to the parts of the body, fo as there to produce their proper actions, which would otherwife eafily be loft thro' their extreme volatility; and when both the oil and the fpirit act together, the effect is more gentle, but more lafting. Thefe fpirits therefore have and communicate to the oil a certain acrimony, which gives the fenfation of fire to the tongue, and prefently occafions pain; and the like effect it fhews when applied to the naked nerves: when applied to the external fkin, they foon occafion the whole feries of an inflammation, and end in a gangrenous efchar. If applied to the lips, or the internal parts of the nofe or palate, where the nerves lie bare, it occafions the fame, with greater violence, and prefently brings on dangerous inflammations. Whence we eafily fee what effects they may produce upon the mouth, throat, ftomach, and inteftines, when imprudently exhibited. Hence thefe oils may juftly be called inflammatory; tho' we before obferved there is no better remedy for immediately raifing the fpirits by their grateful and extraordinary virtue; which can fcarce be explained, for want of general principles, otherwife than by direct experiment. They have not only this refrefhing, but alfo an heating virtue; for if externally applied, or internally taken, they immediately begin to heat the parts of the body, and prefently encreafe this heat thus once begun; but the colder and more languid

guid the body, the lefs they heat it, and *vice verſâ*; fo that when rubbed upon a dead carcafs, they produce no heat at all: whence it is highly dangerous to give them in a burning fever. They alfo encreafe the motion of the nerves by irritation, propelling the fpirits, and perhaps agreeably warming them both; and whilft they perform all this, they attenuate and diffolve vifcidities, fo far as can be done by encreafing the motion of circulation. But we have already enumerated nearly all the virtues, under the twenty-third procefs, which thefe oils have in common, excepting that they differ as to their different degrees of acrimony. They have, however, befides thefe, other virtues no lefs confiderable, and peculiar to each, whereof we have fufficiently fpoke under the hiftory of diftilled waters, efpecially thofe prepared by cohobation. Thus the oils of the life-tree, and of favine, are powerful emmenagogues, where the ftoppage of the menftrual difcharge arifes from a languid circulation. The effential oil of rue is of fervice in the epilepfy, from a cold relaxed ftate of the nerves, and likewife in hyfterical diforders from a cold caufe; that of juniper-berries, in the cold fcurvy, and the pains and heavinefs thence proceeding; and alfo in nephritic complaints, from cold obftructions: that of mint, in an almoft paralytic weaknefs of the ftomach: that of lavender, in the palfey, vertigo, lethargy, and other cold diforders of the head: the fragrant uninflammatory oil of rofes, is a noble reviver of the languid fpirits; that of cinnamon very advantageous in a great paucity of fpirits, without inflammation, either during the periods of pregnancy, delivery, or immediately afterwards, if at the fame time there be no rupture of the veffels: thofe of wormwood, *carduus benedictus*, the leffer centory, camomile, and tanfey, are ufeful againft worms; for which purpofe they may be formed into pills with the crumb of bread, and given in a fufficient dofe upon an empty ftomach; the patient refraining from all kind of aliment for two hours afterwards: thofe of baulm and lemon-peel, in palpitations of the heart, from cold phlegmatic humours; and thofe of marjoram, rofemary, and fage, in obftructions and mucous difcharges of the *uterus* from a cold caufe.

8. If thefe oils be ftrongly ground, for a confiderable time, with thrice their own weight of pure and dry fea-falt, fo as to divide them well, and then again diftilled with water, they become clean, pure and limpid, or freed from their mucilaginous or gummy part, and fitter for keeping, if put up into glafs veffels that are not too alcaline, and having clofe necks well fitted with ground-glafs ftoppels, and fet in a dry cold place: but they lofe of their quantity by this rectification; much grofs matter remaining behind in the ftill, unable to afcend by reafon of its tenacity. Their virtues alfo are leffened, which depend upon their fpirits, becaufe thefe remain in the water ufed in the diftillation, and are alfo diffipated in the water which comes over. This Mr. *Homberg* fhews by a laborious and inftructive, tho' dear experiment; for upon diftilling fuch an oil, with frefh water every time, fix and twenty times over, he at length obtained only a fourth part thereof; the other three fourths becoming an infipid tenacious fubftance, whilft the water, four and twenty times cohobated with the oil, was rendred exceeding fharp, aromatic, faline, or fpirituous (*a*).

(*a*) See *du Hamel. Hiftor. Academ. Reg.* p. 143.

9. When thefe pure oils are, without addition, diftilled in a glafs retort, with a fire carefully and gradually encreafed, they always exhale fome water, and afterwards become more clear, liquid, penetrating, and light; leaving at the bottom of the retort, after the diftillation is performed by a ftrong heat, a black, fixed, fpungy, terreftrial matter: and if the operation be thus feveral times repeated, the greateft part of the oil will be converted into what the chemifts call *caput mortuum*. The excellent Mr. *Boyle*, by this means, reduced a pound of effential oil almoft wholly to earth (*a*).

10. They who have diftilled thefe oils from pure chalk in clean veffels, have found that by cohobating five ounces of oil eight times, upon fifteen ounces of chalk, it afforded only two ounces and one drachm of oil, two drachms and forty-five grains of falt, and half an ounce of a ftrongly faline water, containing the volatile falt of the oil; according to the obfervation of Mr. *Bourdelin* (*b*).

11. Again, thefe oils diftilled from lime flackt in the air, and afterwards made exceeding dry, are fo changed, that a pound of oil being fix times diftilled, in the way of cohobation upon frefh quantities of lime, with an extreme degree of fire, there came over fifteen ounces and an half of water, and one ounce of oil, according to the obfervation of Mr. *Homberg* (*c*). Hence thefe oils are found to confift chiefly of elementary water and earth, a little oil, fpirit, and falt (*d*), and therefore grew from the union of thofe different principles by the action of the fire: whence oil is not a fimple elementary body, but a compound of feveral others. But whether this be really the cafe, or whether experiments may fhew, that thefe oils are rather tranfmutable, I do not take upon me to determine.

12. This may be faid with greater certainty, that the more excellent of thefe oils being diffolved in high rectified fpirit of wine, digefted and diftilled with a gentle fire of 100 degrees, give out their native fpirit to the fpirit of wine, leaving a tenacious oily matter behind; which, being again treated in the fame manner with frefh fpirit of wine, affords more, and thus at laft remains an indolent, fcentlefs, infipid, thick, and tenacious body of oil, perfectly deprived of all its fpirit. And if even pure water be long fhook with thefe oils, it takes to itfelf their fpirit, becomes rich therewith, and thus robs the oil of its virtue; fo that if the operation be often repeated, it at length leaves the like indolent remainder as the fpirit of wine. And hence we are furnifhed with excellent preparations, and learn that thefe oils are feparable into fpirit and oil, a little falt, much water, and much earth; at leaft, that thefe are producible from them by diftillation. But nothing here feems ftranger than that water fhould remain fo tenacioufly mixed with thefe oils, as not to be feparated from them by diftillation twenty times repeated.

13. Hence again it is confirmed to us by this whole hiftory, (1.) That the peculiar tafte and odour of plants wholly refide in their native fpirit. (2.) That the tafte and odour of diftilled aromatic waters is folely owing to

(*a*) See *Boyle* Abr. vol. III. p. 356, & feq.
(*b*) See *du Hamel. Hiftor. Academ. Reg.* p. 413.
(*c*) See *du Hamel.* ibid. pag. 372.
(*d*) See *Memoir. de l'Acad. Roy.* an. 1703. p. 37.

this

this ſpirit, as peculiar to each plant. (3.) That eſſential oils alſo have their reſpective characteriſtics from theſe ſpirits alone. (4.) That the volatile oil of plants chiefly ſerves for detaining theſe ſpirits, and the fixed oil for connecting the ſolid parts together; whence the difference of theſe two oils is very great. (5.) That both the expreſſed and diſtilled oils before explained, are tolerably natural in the plants themſelves. And (6.) that the difference of oils is principally owing to their ſpirits (*a*).

PROCESS XXXI.

A rob from the remains of the twenty-third, twenty-fourth, twenty-fifth, twenty-ſixth, twenty-ſeventh, twenty-eighth, and twenty-ninth proceſſes.

'AFTER the oils are totally extracted from plants by the means of 'water, without any other addition, there remains behind in the ſtill 'the ſame decoction, as if the plants had been boiled for the ſame ſpace of 'time with water in another veſſel; whence the virtues of the plants, except 'what reſided in the oil and ſpirit, will remain in theſe decoctions, unleſs 'perhaps they are ſomewhat changed, by boiling ſo long in a cloſe veſſel; 'and when the decoctions, remaining after the firſt diſtillation, are again 'employed with the diſtilled water, and a freſh ſubject, for obtaining more 'of the ſame oil, this ſecond remainder will be ſtronger than the firſt, and 'ſo after every repetition; thus at length ſuch decoctions become ex-'tremely rich; as we have above obſerved in the hiſtory of diſtilled wa-'ters prepared by cohobation, where we endeavoured to ſhew what theſe 'virtues chiefly are. Thus the decoctions remaining upon the diſtillation 'of betony, fennel, germander, ground-pine, juniper-berries, tanſey, worm-'wood, and many other vegetables, are fit for medicinal uſe; as generally 'retaining a ſaponaceous, ſharp and ſaline virtue, by means whereof, they 'may prove conſiderably ſerviceable. It is juſtly obſerved by *Helmont*, that 'the decoction of juniper-berries, remaining after the oil is drawn off, has 'an excellent purging virtue if taken in a due quantity. And if theſe rich 'decoctions be largely diluted with water, and then run hot thro' a woollen 'ſtrainer, and afterwards evaporated to a rob in a wide veſſel over a clear 'fire, with a degree of heat, a little below that of boiling; their virtues 'will thus remain perfect for ſeveral years, and produce conſiderable effects 'in a ſmall doſe. And if theſe robs be farther inſpiſſated and dried, then 'burnt after the manner of *Tachenius*, they afford his ſalt in plenty; but if 'the decoctions be made perfectly pure by ſtraining, then inſpiſſated to a 'due conſiſtence, and put into veſſels with a little oil poured on the top, 'they will then afford the native ſalts of their reſpective plants, which 'will now ſhoot the freer, thro' the abſence of the oil.

(*a*) See Mr. *Homberg*'s experiment in *du Hamel*'s hiſtory of the royal academy; and *Hoffman*'s *diſſertationes phyſicæ*, pag. 1—63.

The use.

Thus chemiſtry, almoſt at the ſame operation, prepares oils, waters, extracts, native ſalts, and ſalts by calcination, for medicinal uſes: and theſe preparations, being again compounded together, afford excellent medicines. Thus if the oil of juniper be properly ground with the native ſalt of the ſubject, then exactly mixed with the rob thereof, and at length diluted with the diſtilled water of the ſame, we may thus have almoſt all the active parts of the juniper brought into a little compaſs, without the terreſtrial part which hinders their virtue. And from all this we underſtand, what different things may be extracted from a vegetable ſubject, by chemiſtry; and how far one promotes, or hinders the production of another.

PROCESS XXXII.

The diſtilled water, vinegar, ſpirit, two kinds of oil, coal and aſhes from guaiacum wood, diſtilled by the retort, without addition.

THE plants, hitherto chemically examined, ſeem referable to two diſtinct claſſes; the firſt whereof contains thoſe which by a dry diſtillation, beſides their other volatile parts, afford a volatile, acid, oily ſalt; and the ſecond claſs thoſe, which, when treated in the ſame manner, beſides their volatile parts, afford a volatile, alcaline, oily ſalt; but ſo that both claſſes afford more or leſs in very different degrees, according to the difference of the ſeveral plants in each claſs. We now proceed to give an example of both; and begin with the acid claſs, by an example in guaiacum.

'1. Fill a clean glaſs retort, almoſt up to its neck, with the ſmall fine 'chips of the beſt, green, cloſe, ponderous and freſh guaiacum, with care 'to prevent any of it from falling thro' the neck into the receiver. 'Set the retort in a ſand furnace, apply a very large receiver, and lute the 'juncture cloſe with a luting of linſeed-meal. Diſtil firſt with a degree of 'heat not exceeding that of boiling water, and continue this carefully ſo long 'as any moiſture will be thereby driven from the wood. A liquid, tart, 'and ſharply odorous water will thus come over, which is to be poured 'out, and kept apart. The receiver being now again luted on, encreaſe the 'fire by ſlow degrees; and again, a conſiderably limpid, but ſomewhat 'more acid, unctuous, and rediſh liquor will come over, which muſt carefully be urged with the ſame degree of heat, ſo long as it riſes. This alſo 'may be kept ſeparate, as being conſiderably ſtrong, odorous and ſmelling 'almoſt perfectly like red herrings. The fire, being now raiſed and kept 'up, drives over a red, unctuous, and highly acid liquor, together with 'a red oil floating in a conſiderable quantity therein: at length encreaſe 'the fire to the utmoſt, that the bottom of the iron pot may begin to 'be red hot; there will now aſcend a ſmoke, and a thick, black, viſcid 'oil, that ſinks to the bottom of the former liquor. And if this fire be

'continued

'continued as ſtrong as the glaſs will endure without melting, the ſame 'fume will conſtantly continue to riſe, how long ſoever the fire be kept up. 'In the laſt place apply live coals upon the ſand, all around, and above the 'retort, which is called a fire of ſuppreſſion, and keep this up alſo for 'ſome time till no more oil comes over; tho' the fume will ſtill remain 'in the receiver. Now ſuffer all to cool ſpontaneouſly, and by this laſt 'extremity of the fire, a little very thick, black, and ponderous oil, like 'pitch, will be driven over.

'2. Make a little filter of cap-paper, put it into a glaſs funnel, and pour 'therein the water that firſt came over without any oil, that the ſtrainer be'ing thus well moiſtened may tranſmit this pure water of the guaiacum, 'which is to be kept ſeparate. This water will be tartiſh, limpid, and pe'netrating, but have little of the ſmell or taſte of the guaiacum; but a ſome'what burnt odour, a little reſembling that of ſmok'd herrings. Then put 'the ſecond water into the ſame filtre, and this will come thro' a little rediſh, 'tranſparent, but more acid, and ſmelling ſtronger of ſmok'd herrings; ſo 'as to prove ſomewhat empyreumatic, and much ſharper than the former. 'And if any oil were lodged in this ſecond water, it will remain in the 'filtre; which, having been moiſtened by the preceding liquor, will not 'permit the oil to paſs. Into the ſame filtre pour likewiſe the vinegar, and 'third ſpirit, together with its light oil; the vinegar will immediately paſs 'thro' red, pellucid, ſharp, acid and empyreumatical, but leave its oil 'behind floating upon the liquor in the filtre: for which purpoſe the filtre 'muſt always be kept filling up with more of the oily liquor, to prevent the 'oil from ever touching the lower part of the paper; for thus nothing of 'the oil will come thro' with the acid liquor. When now nearly all the 'liquor is come thro', immediately remove the funnel with the filtre to ano'ther glaſs, before the oil begins to ſink thro' the paper; which would hap'pen when the paper begins to grow dry. At this time, therefore, the 'light and thin oil may be poured out of the filtre, into a veſſel apart.

'3. Pour the oil which came over laſt, along with its highly acid, fœtid, 'and unctuous liquor, into the ſame filtre, whilſt it remains ſtill wet with 'the former liquor: there will now come thro' a red, acid, tranſparent 'fluid, and a groſs, black, pitchy, ponderous oil remain in the paper; 'this alſo is to be poured out and kept ſeparate.

'4. If theſe acid liquors be preſerved in clean glaſſes, they depoſite at the 'ſides and bottom thereof a ſmall oily cruſt, which gradually encreaſes, 'whereby the liquor gradually becomes leſs unctuous; whence it appears 'that this diſtilled vinegar is a compound of water, acid, and oil, and may 'therefore properly be called a volatile, acid, oily, ſaponaceous ſalt. If 'this acid liquor, when become perfectly limpid, and affording no more 'viſible oil, be poured upon clean chalk, it effervеſces therewith, depoſites 'its acid in the chalk, and becomes a water that immediately throws the 'oil, before latent in it, to the ſurface, in a viſible form. Or if the ſame 'liquor be again diſtilled with a gentle fire, in a clean veſſel, it alſo pre'ſently manifeſts its latent oil, and ſeparates it from itſelf, and thus becomes 'a pure and clear acid liquor.

'5. If

'5. If the oils be required in greater perfection, let a quantity of them 'be collected, and diftilled from boiling water; whereby the purer part 'will be raifed, and the groffer left behind: and by often repeating this 'operation, thefe oils gradually come nearer to the perfection of the effen-'tial kind, and by lofing their more unactive and terreftrial part, become 'liquid, bright, beautifully red, penetrating, pure, thin, and not fœtid.

'6. When thus all that is volatile has been driven over from the fub-'ject by the violent and long continued action of the fire, extremely black, 'light, infipid, almoft inodorous, and very brittle fhavings remain in the 'retort, being the coal mentioned by *Helmont*, which can never, by the 'moft continued force of fire, be calcined into white afhes, whilft the 'veffel remains clofe, but always continues black, and therefore inflam-'mable; becaufe this blacknefs is the fixed oil tenacioufly adhering to the 'earth, and fubtilly extended upon its furface; whence the coal becomes 'apt to take fire, and burn fo long as this oil remains unconfumed. For if 'thefe black chips be now put into a large open pan, and a fmall live coal 'be thrown into the middle of them, they will immediately burn and flame 'all over, till the whole blacknefs be ignited, after which the fubject pre-'fently falls into white afhes; fo that in a fhort fpace the whole body of 'the fhavings may, by means of the fmalleft fpark, be perfectly converted 'to afhes. Nor could the wood itfelf be fo eafily, and fo readily fired with 'a fmall fpark, unlefs by a like preparation it were firft brought to a coal, 'and then broke to powder. The white afhes thus obtained from *guaiacum* 'are infipid, and inodorous, and almoft without falt; tho' if the wood were 'recent, they prove confiderably rich in alcaline falt.'

The ufe.

There are many remarkable things to be learnt from this experiment, with regard to chemical, philofophical, and medicinal hiftory.

1. And firft we hence learn the nature of that primary fmoky vapour, which exhales from green wood laid upon the fire, before the wood begins to grow black, take flame, or ignite. For thus there exhales an acid, acrimonious water, offenfive to the eyes, and capable of penetrating and preferving fuch animal flefh as is fufpended in the chimney where this vapour rifes: and a liquor extremely like it is collected at both ends of a long piece of green wood, laid with its middle upon the fire; which thus drives out a confiderable quantity of a tartifh water, with a hiffing noife.

2. We hence learn the nature of the firft fmoky vapour, which arifes from dry wood, when applied to the fire, or from green wood after the former liquor is driven off, tho' before the wood begins to ignite or burn; for this fmoke is thicker, more acrimonious, acid, and ponderous than the former, containing more acid falt, and beginning to grow fomewhat black; whence it proves much more offenfive to the eyes, and more ftrongly penetrates, preferves, and cures the flefh, or fifh, fufpended in it, in fome meafure tinging them quite thro' of a redifh colour; whence it carries up with it fome part of the firft oil from the wood.

3. Hence

3. Hence again we learn the nature of that black, grofs, and keen fmoke, which rifes from wood thrown upon live coals, a little before it burfts out into flame; for this fmoke contains a very fharp, fixed, and copious acid falt, together with the firft, fecond, and third pitchy oil of our procefs, all compounded and mixed together; which makes a vapour intolerably pungent to the eyes: and this alfo penetrates the bodies expofed thereto, preferves them by its acid oily falt, alters them farther, and gives them a different fmell and tafte. This fmoke alfo contains the matter of foot.

4. Hence again we learn, that thefe vegetable fubftances afford a water, containing an acid, oily, and volatile falt, which in this ftate has highly penetrating, aperitive, attenuating, healing, detergent, faponaceous virtues, fo as to prove antifcorbutic, diuretic, diaphoretic, and fudorific; efpecially after being well purified and rectified. It is alfo proper for external ufe.

5. Who could have expected that fimple elementary water fhould remain, for fo many years, in a hard, and dry form, fixed in the body of wood, or its other principles. I have fometimes diftilled, by the retort, the chips of guaiacum, kept for many years in the open air, and thus become dry like fand, and poured the acid aqueous liquor collected together, confiderably pure upon chalk or fixed alcali; which eafily abforbed all its acidity, and turned it to a pure and copious water, excepting a certain ftrong fcent that remained therein. This water, which at firft grew to the wood in *America*; and remained united with it fo many years, in an exceeding dry and ponderous ftate, thus at length recovered its native form of water. Whence we clearly fee, that water may remain a long time furprizingly united in bodies, where it would not eafily be fufpected, and prove the principal caufe of their hardnefs; for as foon as this water is by the fire feparated from the other parts of the wood, they prefently become friable, foft, and loofe; tho' a little before, whilft the water remained in them, they were almoft as hard as iron.

6. Hence we fee, that a certain mixture of different principles may, by their proportion, form bodies extremely different from thofe principles.

7. We are hence farther taught, that water, acid falt, fpirit, oils, and earth, may be fo intimately, fecretly, and firmly united, and mixed together by nature, in the production of plants, as not only to remain thus mixed for feveral ages, as we fee in cedar, guaiacum, juniper, *&c.* but alfo to afcend together in diftillation. Nay, that even water is contained in oil, and oil in water, without affording the leaft figns of their being there, as we clearly perceive.

8. We fee that the more fixed oil in vegetables, after all the volatile part is perfectly driven over, remains united with that earth and matter, which turns to a fixed alcali by an open calcination. And that this oil cannot be driven off, or feparated by any force of fire in a clofe veffel, wherein it always retains its black colour, nor affords any figns of an unctuous fubftance, but appears greatly exhaufted. This oil, we find, is fubtilly fpread over the earth and fixed falt, whence it takes fire fo eafily with the leaft fpark, and propagates it over its whole furface by the help of the air; that this oil does not afford a very fmoky fire, tho' it fmells ftrong, and fomewhat aro-

matic,

matic and balfamic; and that this fmall quantity of oil, fo long as it continues, hinders the falt from being yielded by the coal: but as foon as this oil is confumed by the air and fire, the falt immediately fhews itfelf, and remains in the white afhes. All thefe particulars, when duly confidered, will fhew what a wood coal is, and why the black powder of it has fuch ftrange and unexpected effects in chemical operations when mixed with bodies, efpecially fulphureous ones, intended to be changed. The fixed alcali of coal is flowly generated, and not without the utmoft violence of the fire in the open air, after all the inflammable matter is confumed; whilft the laft oil is fo firmly detained by the fixed matter of the plant, as not to be feparated by the fire alone, or without the affiftance of the air. Diftillation therefore, performed in clofe veffels, extracts thefe volatile parts from vegetables, *viz.* a water, a fpirit, an acid falt, two kinds of oil, and in all thefe much earth; but leaves behind the following fixed matters, *viz.* the fixed oil of the coal, a matter convertible into fixed alcali by fire in the open air, and laftly, the elementary earth: whence we underftand the power of the air and fire, acting together upon vegetables.

9. This experiment is univerfal, or holds in all trees, fhrubs, and moft herbs, which, when thus treated, afford all thefe fixed and volatile parts; for they all contain a volatile acid falt, but the matter which affords the faline alcali is fixed. The recent cuttings of the vine, pruned in the beginning of *March*, afford a copious acid by fuch diftillation; and the calcined coal plenty of fixed alcali.

PROCESS XXXIII.

A water, fpirit, volatile alcaline falt, oil and coal, from muftard feed, diftilled by the retort.

IT is well known that there are herbs, and certain parts thereof, which, when a little bruifed, or fcraped, exhale fo pungent a vapour, as when received by the noftrils to caufe fneezing, or touching the eyes to make them water, and at the fame time afford a very pungent fmell, as we remarkably fee in the bulbous roots of garlic, hyacinth, leeks, *Narciffus*, onions, and fquills. Some roots alfo have the fame property as thofe of horfe-radifh, both the white and the black, and both the fpecies of water-radifh, the feeds of hedge-muftard, muftard, radifh, rocket, fcurvy-grafs and treacle-muftard, and a large number of entire plants, particularly arum, afphodel, bryony, cabbage, camomile, celandine, cherlock, clary, *cneoron*, creffes, *datyra*, dittander, euphorbium, garlic, hedge-muftard, henbane, hyacinth, *lycoperficum*, *melongena*, muftard, onions, *orchides*, pepperwort, poppy, ranunculus's, rocket, fauce-alone, fcordium, fcurvy-grafs, *fempervivum acre*, fpurge, tobacco, *thapfia*, treacle-muftard, wild cucumber, *&c.* for the fuccefs of the experiment is nearly the fame in all thefe, and in moft of the virulent and cauftic plants.

1. Fill

'1. Fill a glaſs retort almoſt up to the neck with the ripe ſeed of common 'muſtard; apply a clean and large glaſs receiver thereto, lute the juncture 'exactly, and diſtil, by degrees of heat, in ſand: there will firſt come over 'an unctuous and yellow liquor, which, being collected apart, is ſharp and 'tranſparent. Let the fire be now augmented, and there will riſe a ſpi-'rit like the former, but yellower, and along with it a light and very fat oil, 'which again being collected ſeparate, proves extremely pungent. The emp-'ty receiver being again applied, and the fire increaſed below, and a fire 'of ſuppreſſion made above, there aſcends a copious black oil, and at the 'ſame time a volatile, oily, alcaline ſalt ſticks in grains to the ſides of the 'receiver, as is uſual in the diſtillation of hartſhorn. And if this degree of 'fire be long kept up in its greateſt ſtrength, ſome whitiſh fume will always 'continue to riſe; and at length a very black, light, bitter, ſaline maſs will 'remain at the bottom of the retort, as if made by melting of the ſeed. '(2.) If the firſt and ſecond ſpirit be again diſtilled with a gentle fire in a 'freſh veſſel, it affords a pellucid pungent ſpirit, conſiderably like the ſpirit 'of hartſhorn, and having nearly the ſame uſes; leaving a fetid oily water 'behind. (3.) If the oil be poured off clear from the liquor that aſcended 'laſt, and from the ſalt, and the ſalt adhering to the ſides of the glaſs be 'waſhed down with the rectified ſpirit juſt now deſcribed, a liquor will be 'obtained ſaturated with volatile, alcaline ſalt, and that makes a ſtrong effer-'veſcence with acids; and if diſtilled with a gentle fire in a tall veſſel, it af-'fords, by rectification, a pure volatile ſalt, like that of hartſhorn. (4.) All 'the oils, thus procured, have a fetid, empyreumatic ſmell, but by recti-'fication become purer, and more grateful; being thus reſolved into a copi-'ous earth, and an oil that is always finer. (5.) What remains in the re-'tort after diſtillation ſeems a true coal, which, however, being reduced to 'a dry powder, remains ſomewhat unctuous; nor does it take fire upon 'receiving a ſmall ſpark, as the coal of guaiacum did, from which it there-'fore differs in this reſpect; but when burnt in an open fire, it leaves a 'little earth behind, that, ſo far as I have tried, ſcarce affords any fixed 'ſalt: but I have been very credibly informed that this coal of muſtard-ſeed, 'when collected in a large quantity, and ground to powder, and long diſtil-'led with a ſtrong fire, in an earthen coated retort, thus at length afforded 'true phoſphorus, like that of urine.'

The uſe.

1. All theſe remarkable particulars, when compared with what we ſhall hereafter ſee, in the analytical hiſtory of animals, will clearly ſhew that this kind of plant, and thoſe above ſet down, correſpond with animal ſubſtances in this chemical analyſis; ſo that if any, there is at moſt but little difference between them, as to their productions, except that the parts of animals, perhaps, afford a little more water without oil; tho' this alſo might probably happen in muſtard-ſeed, when analyſed green. Thus much is certain, that muſtard-ſeed, when ſown, does, by attracting the juice of the earth, produce a plant, which ſo diſpoſes the matter of the vegetable, as to be

 changed

changed into a volatile alcaline ſalt, by the force of fire; whence this ſalt is not ſo peculiar to animals, as not alſo to obtain in certain vegetables: and even without fire this alcaline ſalt appears more in muſtard, than in urine, tho' urine be the moſt alcaline of all the animal juices. For I never found any human urine that would make an efferveſcence upon mixing with acids; but on the other hand, have found that good muſtard-ſeed, being barely bruiſed, would make an efferveſcence with ſtrong vinegar poured upon it. Hence, therefore, a true volatile, alcaline, oily ſalt may be produced from plants, without any previous putrefaction, and barely from crude natural and recent plants, whether they grow on dunghils, as hedge-muſtard, muſtard, rocket; or in water, as creſſes, horſe-radiſh, and ſcurvy-graſs: tho' one would not eaſily expect a volatile alcaline ſalt ſhould proceed from water.

2. Hence phyſicians may know with certainty where the uſe of theſe herbs is wholeſom to the body; for they prove excellent when prudently given in diſtempers attended with an indolent, watery, or cold phlegmatic humour, no way ſaline; where acid humours are lodged in the firſt paſſages; where the bile is ſluggiſh, and where no alcaline, fetid, or oily putrid matter is lodged; but the body remains cold, torpid, and ſwelled all over: as on the other hand, they prove hurtful where the body is hot and feveriſh, the bile ſharp, the juices putrid, the parts inflamed or waſted; or where the putrid ſcurvy abounds. And it were highly uſeful to take a view of the ſeveral plants as they are diſtributed into theſe two claſſes; the one affording an acid, and the other an alcaline ſalt.

PROCESS XXXIV.

The ſeparation of the oils joined with the other principles in diſtillation; or their depuration, conſervation, and converſion into balſam and reſin.

' 1. OILS ſhould be ſeparated pure from all other matters, in order to ' their being juſtly examined and preſerved, and to ſhew what befals them in keeping. (1.) This ſeparation is uſually performed, firſt by ' the filtre: thus, cut a piece of filtring paper into the form of a conical bag, ' and fit it into a clean glaſs funnel, ſtanding in the neck of a glaſs veſſel; ' then moiſtning the paper well by pouring clean warm water upon it, ' pour in the mixture of water, ſpirit, and oil; the water, ſpirit, and ' the ſalt diſſolved therein will ſoon paſs thro', and leave the oil behind. ' Continue to pour in more of the mixture, till all be filtred; with care to ' prevent the oil from remaining alone in the filtre, by continually pouring ' on more of the mixture before all the former water is run through; by ' which means the oil alone will be found in the filtre, and the water eſcape. ' Then let this oil be immediately poured out of the filtre into a glaſs, and ' kept ſeparate. But, as much of the oil here ſticks to the paper, the chemiſts have found another method of ſeparation for the dearer oils. (2.) ' Let a glaſs be procured with a long cylindrical neck, ending in a wide ' orifice;

'orifice; heat this glafs, and pour the water, with its rich oil that floats on 'the top, into it, till the glafs be full to the very top; then fuffer it to reft, 'and all the oil will rife to the neck, whilft the water remains below: then 'pour off all the oil, if poffible, into another glafs, by gently inclining the 'veffel; but if all the oil does not thus come away, pour as much hot wa-'ter into the neck as there was oil poured off; which water, finking below 'the oil, will raife all the oil upwards into the neck of the glafs, from 'whence it may again be poured off pure. And thus by repeating the ope-'ration, all the oil collected in the neck may be thus feparated, even to a 'few drops, by the means of heat, a proper agitation, and the filling up 'of the veffel. (3.) The fame end is obtained by means of a glafs called 'the feparating-glafs, which is a bellied glafs that rifes with a narrow neck, 'but defcends in a conical tube open at the end; the mixture being poured 'into this glafs, the oil will rife together at the top, after which the lower 'orifice being opened, the water firft runs out. When the oil begins to 'come into the narrow ftem, the paffage fhould be immediately ftopped; 'and now more of the mixture being poured in at the top, the whole oil 'by degrees is collected, and the water let go; the oil at length thus re-'maining alone in the glafs. (4.) But if the oil be fo ponderous as to fink 'in the water, when the mixture is thus poured into the feparating-glafs, 'the oil will fall into the flender fhank, and the water float above; fo that 'after being fuffered to reft, the oil is firft tranfmitted below, till the water 'begins to come into the narrow part; and thus again the oil is obtained 'feparate from the water. (5.) Laftly, when any water ftill continues to 'float upon thefe precious and ponderous oils, it ought to be taken off, 'otherwife it would render them ropy; the way to take it off is by a 'wreath of filtring paper, brought to a fharp point, then dipped in water, 'fo as to grow moift therein; when being fqueezed dry, and the point ap-'plied to the water floating on the furface of the oil, it attracts the water 'to itfelf, and leaves the oil pure.

The ufe.

1. The oils thus feparated are to be put up in fmall and clean glaffes, exactly fitted with glafs ftoppels, then fet in a cold dry place, and opened as little as poffible; left the fpirit, which gives the virtue and value to the oil, fhould exhale. And if a little perfect alcohol be mixed with moft of thefe oils, they hence become thinner and fitter for ufe and keeping, and are thus prevented from growing fo thick afterwards as not to drop from the lip of the glafs. It alfo prevents thefe oils from growing mucilaginous, or rancid, as they might otherwife do; and even recovers them when they be-gin to corrupt.

2. But by long keeping, thefe oils acquire the thicknefs of a balfam, and at laft harden into a kind of rofin; and this change is eafily occafioned, if the prefiding fpirit exhale, either by opening the containing glafs too often, or leaving it not well ftopped, efpecially in a hot and dry place; but fooneft of all, if the glafs be left open, for then they become real rofins; whence I

have fometimes fufpected that this fpirit is what keeps the oils fluid. I once included an extremely pure diftilled oil in a glafs, and having occafion for it a year after, I viewed it, and was furprized to find it thick; when ufing another in its ftead, and fetting the former by again, it in three or four years time became as thick as turpentine: and hence it is that bodies, dipped in diftilled oil of turpentine, and then fufpended in the air, where no duft comes at them, acquire a tranfparent réfinous cafe, wherein they are excellently preferved for a very long time unaltered.

3. By this means therefore the proper fpirits of vegetables being freed from their grofs bodies, and detained in their tenacious fulphur, may be long preferved for the neceffary ufes; and being thus reduced to a fmall bulk, be carried into foreign countries without lofs of their virtue; fo that inftead of a hundred weight of cinnamon, a little bottle of its oil, containing all its virtues, fo far as they depend on its native fpirit, may, without incumbrance, be kept or exported in its ftead. And this artificial method feems extremely natural, fo as but little to alter or impair the particular medicinal virtues of plants, which it thus collects together, and renders extremely durable; fo that were it only for this invention, and its ufes, chemiftry might fufficiently recommend itfelf to phyficians.

4. But as moft of the effential oils are very dear, it has been ufual to adulterate them, firft by putting bruifed almonds into the ftill, whereby the oil of the almonds, coming to rife with the boiling heat, mixes itfelf with the effential oils, and increafes their quantity. Others practife this fallacy, by adding bruifed poppy-feeds in the like manner (*a*). Others knowing that thefe rich effential oils will perfectly diffolve in highly rectified fpirit of wine, and thence become the ftronger, adulterate them therewith, without leffening but exalting their virtues, whilft they gain the difference between the price of the two by this artifice. But the former cheat is difcovered by the admixture of hot water, which eafily feparates the lighter oil from the heavier aromatic kind; the one thus rifing to the top, and the other finking to the bottom; or again, by the admixture of pure fpirit of wine, which unites with the effential oil, and not with the other more infipid one: and the latter fallacy is detected by mixing the adulterated oil with water; for thus the mixture growing white, this will feparate the oil from the fpirit of wine, and fhew nearly in what proportion the oil was adulterated therewith.

PROCESS XXXV.

The vinegar, fpirit, two kinds of oil, rofin and colophony, from turpentine, diftilled by the retort.

WE have before feen, that the native oils of plants are neither fimple bodies, nor of a very unalterable nature; and fome of the preceding

(*a*) There feems to be fome confufion throughout this procefs, and its ufes, arifing from mixing together two different confiderations of *effential oils*, and that of oils diftilled by the retort: will almonds, or poppy-feeds, yield any confiderable quantity of oil, by diftillation with water?

experiments

experiments have discovered their various principles, and the new productions they afford upon being changed. It seems therefore necessary, that we farther proceed to examine those oils spontaneously produced by nature from the bodies of plants, and collected on their outside, under the name of balsam or turpentine.

'1. Take a clean new glass retort with a wide neck, and cut it off short, 'so that the mouth may remain large and capacious, which is a principal 'requisite in this operation; then heat pure native turpentine in an earthen 'vessel, having a lip to pour out at, by putting the vessel into scalding hot 'water, till the turpentine grows fluid like water; then pour this melted turpentine hot in at the wide mouth of the retort, which is first to be strongly heated to prevent its cracking as the turpentine is poured in. Let two 'thirds of the retort be thus filled, and leave the other third empty; then 'hold the retort, so filled, with its neck erect, till the turpentine shall have 'run quite down the neck into the belly, if any of it happen to stick to 'the neck in the pouring; otherwise this gross turpentine would run down 'into the receiver in the distillation, and foul the liquor that first comes over: 'now place the retort in a sand-furnace, and lute on a clean receiver. (2.) 'Make a fire that may heat the sand to about 100 degrees, and carefully 'keep it at this height, so long as it drives over any liquor; by which 'means a thin limpid fluid, resembling water, will come over, and fall to 'the bottom of the receiver, whilst another limpid, thin, and oily liquor 'floats upon it. When nothing more rises with this degree of fire, change the 'receiver; the under liquor will be found gratefully acid, saline, aqueous, 'miscible with water, refreshing to the stomach, spirituous and excellently 'diuretic. It will make an effervescence with chalk, deposite its acidity 'therein, and afterwards distil from it in form of a pure water: whence the 'acid salt, and water first come over in this distillation. The other liquor, 'which floats upon this, is a light, pure, thin, almost spirituous and inflammable oil, thence called the ætherial oil of turpentine, which is so penetrating as to vanish when rubbed upon the body, pass into the blood, and 'soon communicate a violet smell to the urine; which is an evident sign 'of the power it has to pass thro' all the pores. (3.) Let a proper receiver 'be now applied, and an heat equal to that of boiling water, be raised; this 'is done by pouring water upon the sand, and heating it with the fire underneath to 212 degrees; where it is to be kept by continually adding as 'much boiling water as exhales away. The matter remaining in the retort, 'after the first operation, is left so thick as to appear consistent in the cold; 'but now melts again, crackles between whiles, and again affords an acid 'water, like the former, that falls to the bottom, and an oil also like the 'former, floating at the top, but somewhat thicker, and a little yellowish: 'both of them have nearly the same virtues as mentioned above. (4.) The 'receiver being again changed, and the fire gradually encreased up to 'a strong degree of a sand-heat, tho' with caution in the raising it, there 'will come over an acid, ponderous, red water, that runs separate into the 'bottom of the receiver, and a thick, red, penetrating, tho' somewhat viscous oil floating on its top; and it is remarkable, that this acid water al-

'ways

'ways continues to riſe along with the oil; and not the water firſt by itſelf, 'and the oil afterwards: what now remains in the bottom after this laſt 'diſtillation, proves, when cold, exceeding red, hard, and brittle. (5.) I 'have urged this remaining matter with caution, and by ſlow degrees, up to 'the ſtrongeſt heat that ſand and a fire of ſuppreſſion would afford, and have 'thus obtained red oil, ſo thick and viſcous, as to reſemble turpentine itſelf, 'but it was of a red colour, and ſome red, acid, ponderous water ſtill conti-'nued to riſe with it: leaving ſcarce any thing behind at the bottom of the 'retort. (6.) There is the greateſt caution required in this diſtillation, to 'prevent the glaſſes burſting or cracking, whereby a denſe, oily fume would 'immediately eſcape, which readily takes fire, and can ſcarce be extinguiſh-'ed; whilſt the fire is impetuouſly hurried into the retort with a flame that 'burſt the veſſels to pieces in a dangerous manner. (7.) Turpentine is 'otherwiſe commonly diſtilled into an acid water, an ætherial oil, or ſpirit 'of turpentine, after this manner. Fill one third of a bath-alembic (*a*) with 'pure rain-water; and add thereto half its weight of good turpentine; then 'fix on the head, and uſe the worm and refrigeratory; thus diſtilling with 'care, and a fire that makes the matter gently boil, there comes over an 'acid water, and a pure light oil; if the diſtillation be continued ſo 'long as this oil continues to run, there now remains behind a kind of 'colophony in the ſtill: and if the flowers of lavender, roſes, or other odo-'riferous plants be here put into the ſtill, the oil will come over fragrant 'by this operation. Therefore turpentine is reſolvable into water, a ſaline, 'acid ſpirit, a volatile oil, and a more fixed colophony. (8.) It is here 'chiefly remarkable, that the remainder proves ſo much the thicker, redder, 'harder, and more brittle, the more water, acid, or volatile oil comes over; 'and that even this laſt fixed matter itſelf at length liquifies, and becomes 'volatile with the utmoſt violence of the fire: and this acid water, being 'well ſeparated and rectified from all its oil, perhaps, affords the beſt vege-'table acid hitherto known.

The uſe.

1. Hence we learn under what form native oils reſide in plants: for firſt, the nutrimental juice drawn from the earth ſeems to be a ſomewhat tart and aqueous liquor, which, when received, gradually depoſites its more unctuous matter in certain parts of the plant, and this unctuous matter afterwards uniting more of the ſame to itſelf, by heat, maturation, and the aſſiſtance of the whole power of the plant, it then appears in the form of a fat oil; which being driven outwards, and undergoing the ſame changes in a greater degree, at length conſtitutes a balſam, containing a water, a ſaline acid, and unctuous ſpirit, and different kinds of oil, all mixed together, yet ſeparable; and after the ſeparation of any particular part, the balſam conſtantly changes to a different form. Hence appears the great difference of native balſams in chirurgical and other medicinal uſes: whilſt they act in

(*a*) See the chapter of furnaces, furnace the third.

their

their own ſubſtance, and ſo by means of all their principles together, or only by means of certain, particular, ſeparated parts. When uſed entire, and mixed with the yolk of an egg, turpentine becomes ſomewhat more ſoluble, and an admirable remedy for external chirurgical uſes; and internally, it proves excellent in many diſtempers, where it gives ſigns of its extraordinary virtue by its penetrating nature, and the violet ſmell it communicates to the urine. We have many balſams of this kind, not differing ſo much in virtue, as in price and place of growth, as the *Aſiatic*, *Egyptian*, *Hierechuntan*, *Judaic*, *Memphitic* balſams, and balm of *Gilead*; for theſe ſeveral names at this day denote the ſame thing; or a white balſam in the form of a liquid turpentine, and of a citron ſmell. The *American* balſams are various, and proceed from different trees, as the balſam of *Capivi*, which is of extraordinary virtues; the balſam of *Peru*, *Tolu*, and liquid amber. The true turpentine proceeds from the turpentine-tree of *Chio*, the fir, the larch, and the pine; but all theſe kinds generally reſolve into the ſame principles by heat and diſtillation, change alike with time, and produce the ſame effects.

2. We know likewiſe that all the kinds we are hitherto acquainted with, contain an acid water, or ſpirit, which is volatile, preſervative, hungry, or eager and penetrating, of great medicinal virtue and fragrance: this ſpirit eaſily exhales, and leaves the balſam deprived thereof, and therefore leſs excellent; whence theſe balſams are not the better for keeping.

3. The oils which firſt come over are light, limpid, totally inflammable, extremely penetrating, bitter, and of great uſe in chirurgery, as being highly anodyne, reſolving, and healing, when applied warm to the membranes, nerves, or tendons, that are lacerated, pricked, or cut; and an immediate, and ſafe ſtyptic, applied to the wounded veins or arteries in large hæmorrhages; as at once defending the nerves, ſtopping putrefaction, and incarning. In theſe caſes it ſhould be applied very hot to the part; and kept thereon by a proper pledget and bandage (*a*). Its balſamic or imbalming virtue is extraordinary; for if the bodies, or parts, of any animals be for ſome time ſteeped in this liquor, then taken out, and awhile ſuſpended in the air, and afterwards dipt afreſh, they at length acquire a caſe, under which they may be long preſerved from putrefaction: but the bodies plunged into this oil, whilſt contained in glaſſes, are preſerved perfectly uncorrupted. It has however this inconvenience, that it gradually grows opake and thick. The oil being uſed hot externally, diſcuſſes cold, viſcid, and mucous tumours, defends the parts againſt cold, relaxes and ſoftens them. When uſed internally, it alſo proves aperitive, heating, ſudorific, and diuretic, communicating a quick ſmell of violets to the urine: whence it proves ſerviceable in the cold fits of intermitting fevers; and being rubbed along the back bone, before the cold fit is expected, it will even cure quartans. It muſt however be uſed with caution, becauſe if taken too largely it affects the head, occaſioning heat and pain therein, and alſo proves violently diuretic, and occaſions an effuſion of the liquor of the proſtrate glands and the *ſemen*, and, therefore, if uſed with moderation, it excites venery: hence it came

(*a*) See *Young's Triumphal Car of Turpentine*, Printed at London 1679. 8vo.

to be recommended in the cure of a venereal running, where it often proves mifchievous; as being apt, when freely ufed, to inflame the parts, and encreafe this diforder.

4. The thicker oils that come over in this diftillation are more balfamic, incarnative, and anodyne, more penetrating and emollient, and are therefore ufed as ftyptics inftead of the former thinner balfam, in hotter and more inflammatory conftitutions; in other refpects they agree with the former: but the laft thick, and vifcous oil, is an admirable incarnative, that heals almoft without fuppuration, and a moft extraordinary anodyne. This oil alfo makes fuch an effervefcence with *Glauber*'s ftrong fpirit of nitre, as often to take flame.

5. What remains behind upon the diftillation of pure turpentine with water, or after the firft oil and fpirit are drawn over, proves hard, brittle, tranfparant, and red in the cold. If this be gently melted, and any infect be dipped therein, and carefully taken out again, it will be furrounded with a tranfparent cafe like amber, thro' which the fubject may be commodioufly viewed; and the whole may be thus kept for a long time beautiful and unaltered, provided the polifh be not obfcured, as it eafily is, on account of the great brittlenefs of this refinous cruft. But the colophony remaining after the fecond diftillation is harder and redder, and eafily reducible to fine powder which has little fmell or tafte. This is that extremely ufeful powder, which is fo advantageoufly applied to the bare bones, *periofteum*, tendons or mufcles, in cafe they are either burnt, corroded, bruifed, cut, pricked, or lacerated; and affords an excellent remedy in the ferous flux of the joints, and admirably procures a cicatrix: in the fame manner it takes down the fungous excrefcencies of ulcers; whence it appears, that turpentine ferves for many chirurgical purpofes. But nothing is here more extraordinary than the fucceffive fpontaneous infpiffation of the firft exceeding thin oil, fo as to recover the thicknefs of turpentine again, and afterwards the confiftence of a thicker balfam, and at length of a rofin; tho' there is lefs acid in thefe regenerated rofins, than in the native.

6. Poffibly, therefore, the native, acid, volatile falt contained in this fat unctuous fubftance, and in the water, is the fame fpirit, which, in other effential oils conftitutes the aromatic fpirit; for it is fo lodged in the native fat, as, together with the water, to lye concealed under the form of one mixed body: whence natural balfams are changed into oils upon lofing their water, and their rofin. Again, balfams are changed into rofins upon lofing their water, acid, and oil; whence this happens fpontaneoufly with time in the open air, whilft the action of the fun, by diffipating the acid, the water, and the thin oil, at length, thro' various degrees, brings it to a rofin. Whence oils in the fpring, are rofins in the winter, and in autumn afford a proper covering to trees, fo as to defend them from cold, drynefs and froft.

7. This experiment clearly fhews, (1.) That the utmoft heat of the fun, long continued, may gradually infpiffate and change liquid oils, thro' various degrees of thicknefs, up to that of rofin, or colophony. (2.) That the heat of boiling water has this effect fooner; and by difcharging the oil, leaves a

colophony

colophony behind, in four or five hours time, whilſt the exhaling fume proves an acid water, and a ſpirit mixed among a large quantity of oil; the colophony remaining hard behind. (3.) That this colophony, being urged by an heat of 280 degrees, is again reſolved into an acid water, and a red, viſcous, ponderous oil, leaving an extremely hard, tranſparent colophony behind, of a colour compounded of red and black, and capable of enduring unaltered for ages. But when this itſelf comes again to be urged with the utmoſt violence of a fire of ſuppreſſion, ſo as almoſt to melt the glaſs, its whole quantity is, by the ſole force of the fire, turned into an oily liquid ſubſtance, tho' ſomewhat viſcous, without leaving any hard colophony behind. (4.) Whence we learn both the changeable nature of vegetable oils, and the ſurprizing variety of the action of the fire upon them; which, with a certain degree of heat, inſpiſſates thin oils, and brings them to an hard conſiſtent maſs, that would always remain the ſame; tho' a greater degree of fire again reduces it to a liquid oil, which likewiſe would long continue in this ſtate; but by a repeated diſtillation, with a ſtrong fire, it becomes totally liquid, and conſiderably thin: whence it is certain that many bodies owe their hardneſs, and others their fluidity to the fire.

PROCESS XXXVI.

The water, vinegar, fetid ſpirit, and butter, from wax, diſtilled by the retort.

CERTAIN balſams appear, in a very ſmall quantity, upon the ſurface of the leaves of ſome plants, where they are inſpiſſated by the heat of the ſun; as ſeems manifeſtly to appear in roſemary. There are alſo often found in other plants certain very minute globules, riſing from the open ſeminal tufts in the main part of the flower; theſe can ſcarce be collected by any human means, but I have ſometimes found, upon frequently cohobating ſpirit of wine upon roſemary leaves, an unexpected and ungrateful taſte or ſmell of wax, fouling the ſpirit, which before was good; and upon viewing theſe leaves with a microſcope, I thought I diſcovered little waxy riſings of the ſurface, and upon handling them conſiderably, I evidently found wax gradually ſticking to my fingers. Wax, therefore, appears to be a certain ſpecies of turpentine which the fat juices of plants, when heated by the ſun, ſweat out upon the ſurface, or produce within the cavities of the flowery tufts. This the bees collect, roll up into little balls, and carry between their hind feet to their hives, where it is wrought into the cells of their combs; and from hence, after the honey is ſeparated from the droſſy parts, it is procured for human uſes. It is generally yellow, and not ungrateful either in taſte or ſmell; it becomes hard and almoſt brittle in the cold, but grows ſoft, and diſſolves with heat.

The process.

'Half fill a glafs retort with fine wax, cut into pieces fmall enough to 'enter the wide mouth thereof; then pour clean fand upon it, fo as to fill 'the retort, which is now to be gently warmed till the wax melts, and 'fufficiently imbibes and mixes among the fand: fet the retort in a fand 'furnace, apply a receiver, and diftil with a gradual fire: there ufually 'firft comes over a little tartifh water, of a difagreeable fetid odour, along 'with a little fpirit; when with the gentle heat of 214 degrees nothing more 'afcends, change the receiver, and raife the fire; by which means there 'will gradually arife a thin oil of a whitifh colour, and concrete, like butter, 'in the receiver. When this ceafes, apply a violent fire of fuppreffion, 'upon which the whole body of the wax will foon come over into the 'receiver, and there appear in a folid form, like butter; having loft the 'hard brittle nature of wax, and melting oily. So much fand fhould be 'here mixed with the wax, as to prevent its explofive fwelling, as would 'otherwife happen in the boiling.'

The use.

It is hence manifeft that the whole body of wax is volatile, with a certain degree of fire, as we before faw of turpentine; in which refpect therefore thefe fubftances agree with camphire, tho' camphire be much more volatile than the other two. Hence we fee alfo that wax, which is wholly inflammable, may exift in a hard and almoft brittle form; and when diffolved in hot water, then forced thro' a linen ftrainer, and poured into fhallow, metalline moulds, fo as to form little cakes; thefe being expofed to the open air and fun, and frequently fprinkled with pure water, the wax is thus blanched or whitened; and tho' it now alfo wholly confumes in flame, yet it is almoft as brittle as glafs: fo as to feem a very different thing from oil. Inflammable vegetable oils, therefore, may exift under the various forms of oil, balfam, rofin, pitch, dry tears, wax and butter. And hence we fee, the fire can make true liquid oils from bodies, which appeared not to be oils before; as we evidently fee in the diftillation of colophony and wax. And this converfion of wax into butter is durable; for it does not return to hard wax again in a very long time, but conftantly remains a foft butter, even in the greateft cold. I have kept this butter of wax above twenty years, in a glafs cylindrical veffel, whofe wide mouth was only loofely covered with paper, yet in all this time it did not return into wax; whereas the moft liquid oil of turpentine foon grows thick, like thin turpentine itfelf; fo that the different effects of fire upon the bare oily parts of plants is furprizing: confequently no certain rules can hence be laid down for the action of fire upon oils. Camphire, which is a pure inflammable oil, becomes camphire again, and not a liquid oil, after being raifed by the fire. The butter of wax thus prepared affords an extremely foft anodyne unguent, agreeable to the nerves, highly emollient and relaxing, and when rubbed upon the parts proves

proves ſerviceable in contractions of the limbs, and ſucceſsfully preſerves the ſkin from roughneſs, dryneſs, and cracking in the cold, or the winter: it alſo proves excellent in the ſharp pains of the hæmorrhoids.

PROCESS XXXVII.

The butter of wax turned into a liquid oil, upon repeated diſtillation by the retort.

'MELT the butter of wax, over a gentle fire, to a liquid oil, then pour 'it thro' a funnel, firſt well heated, into a glaſs retort alſo well heat-'ed before-hand, ſo as to half fill the retort, with care to prevent any of 'the butter from ſticking to the neck thereof, becauſe in that caſe the groſs 'matter would fall into the receiver, which ſhould here be avoided. Set 'the retort in a ſand furnace, lute on a clean receiver, and diſtil cautiouſly, 'managing the fire ſo that one drop may follow another at the diſtance of 'ſix ſeconds; when nothing more comes over with this degree of heat, raiſe 'the fire, and diſtil as before, and continue in this manner increaſing the 'fire with the ſame caution, ſo long as any butter remains in the retort; 'and by this means all the butter will come over, ſcarce leaving any fæces 'behind; and a thickiſh oil, not much diminiſhed in quantity, be found in-'ſtead of butter in the receiver. If this oil of wax be again diſtilled in 'like manner, it always becomes more liquid, ſoft, tranſparent, and thin, 'ſo as at length to reſemble a ſubtile, limpid oil: and the oftener the diſtilla-'tion is repeated, the more mild and gentle, yet the more penetrating the 'oil becomes.

The uſe.

Hence it appears, that the action of the fire more and more attenuates certain oily bodies of plants, yet without rendring them acrimonious, but on the contrary always milder, tho' at the ſame time more penetrating; for this laſt oil of wax is an incomparable remedy for the diſeaſes of the nervous *papillæ* in the external ſkin, and has ſcarce its equal in curing chapt lips in the winter, chapt nipples in the women who give ſuck, and in the cracking of the ſkin of the hands and fingers, being ſometimes gently anointed thereon. It is alſo ſerviceable in diſcuſſing cold tumours ariſing on the face or fingers in the winter; and curing contracted tendons, and the rigidity of the limbs thence ariſing; being uſed along with baths, fomentations, and motion; for it has a ſingular virtue in thus reſtoring flexibility to the parts: being frequently rubbed upon the *abdomen*, it prevents coſtiveneſs; and is therefore excellent in effectually curing the diſeaſes of children.

PROCESS XXXVIII.

Medicated elæoſaccharums.

AFTER the chemiſts had juſtly ſhewn phyſicians, the ſpirit reſiding in eſſential oils, contained, in a ſmall volume, all the particular virtues of the plant; phyſicians prudently reflected, that they hence had an excellent inſtrument in their art, but that the unctuous tenacity of the oil ſtill prevented its being uſed with ſafety, becauſe theſe oils being extremely ſharp, and by their tenacity remaining fixed to one part, occaſioned inflammations. Hence they began to think of a method of rendring theſe oils miſcible with water, and uniformly conveying their entire virtues to the places intended, and this they found might be effected by the means of ſugar.

'1. Grind therefore an ounce of dry loaf ſugar to an impalpable powder, 'in a glaſs mortar, with a glaſs peſtle, and by degrees add thereto a drachm 'of any eſſential oil, or half a drachm, if the oil be very tenacious, and 'continue rubbing them together till all the oil be throughly mixed, and 'drank into the ſugar; the oil, in this operation, uſually diffuſes a fragrancy 'to a great diſtance; whence the operation ſhould be performed quick, and 'the mortar be covered with a cloth ſurrounding the peſtle. If a little 'freſh white of egg be added in the grinding, and mixed in with the ſugar 'and oil, the oil thus becomes more eaſily miſcible, but the mixture will 'not thus keep ſo long without turning rancid. And thus ſugar, which is 'a pure ſoap, or a true eſſential oily ſalt, divides the glutinous tenacity of 'the oil, interpoſes itſelf betwixt the principles thereof, unites them cloſely 'with itſelf, and makes an extemporaneous ſoap; which may thus be com'modiouſly diluted with water for medicinal uſes; for tho' this mixture is 'not ſo perfect as in an actual ſoap, or true eſſential ſalt, yet it ſuffices for 'uſe: nor is there reaſon to apprehend any inconvenience from the ſugar in 'this preparation; for ſugar is unjuſtly ſaid to be unwholeſom, as there are 'no proofs extant thereof. On the contrary, it is a wonderful ſalt that per'fectly mixes with water, and ferments therewith into wine; and yet what 'is again ſurprizing, it appears oleaginous, and perfectly inflammable in 'the fire: whence it is known to conſiſt of oil and ſalt.

'2. If theſe elæoſaccharums be well prepared, dried, and put up into 'clean glaſſes, exactly cloſed with glaſs ſtoppels, they may long be pre'ſerved perfect; and in this manner, very effectual medicines might be com'modiouſly carried from place to place, and upon occaſion be directly uſed 'upon a journey, by adding a little of the elæoſaccharum to a glaſs of 'wine. An elæoſaccharum might alſo be made by grinding an eſſential oil 'with a fixed alcaline ſalt, by which means alſo a kind of ſoap is obtained; 'but alcalies thus deſtroy the grateful properties of the eſſential oils, and 'change their natural taſtes and odours. Such elæoſaccharums alſo would 'preſently reſolve in the air, and thence be eaſily altered. By the former

'method,

'method, therefore, phyficians may prepare an excellent medicine, rich in 'virtues: for if the elæofaccharum of mint be diffolved in diftilled mint 'water, then ftrengthened with the addition of the fpirit of mint, and the 'mixture fweetned with the fyrup of the fame plant, the whole virtues of 'mint may thus be obtained.'

The ufe.

Hence appears the faponaceous property of fugar, which fits it for breaking and dividing the bodies of oils, as if they were in a manner fermented with fugar; and at the fame time it does not diminifh, but rather improves the particular virtues of thefe oils: whence the ancients, who were unacquainted with fugar, mixed oils with honey for the like purpofe. And hence we learn the virtue of fugar in the body, where being diluted with the natural juices, it affords a faponaceous lixivium, which, by the force of circulation, diffolves unctuous and vifcous matters: whence it does not generate but diffolve phlegm, nor increafe the bile, nor turn into it, but opens, thins, and divides it; tho' by diffolving the oils too much, it may occafion leannefs, as by attenuating too much it produces a weaknefs and relaxation of the parts, and is therefore often found hurtful in the rickets and the fcurvy. In the mean time, this production of nature and art is, as we above obferved, very fingular and extraordinary; for it entirely diffolves in water, melts in the fire, fhoots like a perfect falt into perfect cryftals, is manifeftly fixt, and if diftilled in clofe veffels, affords an acid penetrating fpirit. In an open fire it becomes wholly inflammable; it is fermentable, and thus convertible into ftrong wine, that will afford alcohol; and laftly, it may be converted into fharp vinegar. If it be called a falt, we may afk how it comes to be inflammable in the fire; if an oil, how it comes to cryftallize; if an effential falt, how it comes to ferment: fo that, perhaps, in all nature there is no other body found in which all thefe properties confpire?

PROCESS XXXIX.

Medicated liquors, made by means of many of the preceding proceffes.

THE prefent and preceding procefs are principally of ufe to phyficians, who apply the known virtues of plants to the body.

'Take therefore a drachm of any elæofaccharum, and two drachms of 'the medicated falt of *Tachenius*, grind them together ftrongly, and for a 'confiderable time, in a glafs mortar, till they become throughly mixed; then 'add fix ounces of the cohobated diftilled water of the fame plant, from 'whence the elæofaccharum was made; and if a fyrup of the fame plant be 'kept in the fhops, a little thereof may alfo be added: and thus in a fmall 'compafs the virtue of a plant may be collected together for medicinal ufe, 'and act according to its own nature in the body. The falt of *Tachenius* 'will not here communicate any virtue foreign to the defign, tho' prepared

'from

'from a different plant; for as we have ſhewn from the hiſtory of that ſalt, 'the particular virtue of plants does not reſide in this, but in their eſſential 'oil, and the ſalt itſelf rather in the common matter of the plant. If a per- 'ſon, therefore, for making this medicated liquor from cinnamon, ſhould 'add the ſalt obtained from burnt cinnamon, he would loſe more of the 'ſpice, or more labour, than the virtue of the liquor would anſwer.'

By this means the proper virtues of every plant are obtained concentrated, becauſe the elementary water is the ſame in all plants, and therefore does not alter their effects; the ſalt alſo loſes its own nature in the burning, ſcarce retaining more than the common one, and therefore proves of the ſame virtues, whatever be the plant that afforded it: ſo that all the peculiar virtue of a plant remains in its preſiding ſpirit, which is here ſeparated and lodged in the oil; whence this preparation is extremely commodious, efficacious and uſeful, if the medicinal virtue of the plant be previouſly well known; for thus we obtain a certain, tho' indeed a leſs perfect kind of ſaponaceous, oily eſſential ſalt of the plant, than that in which the excellent *Helmont* places nearly all the efficacy of medicines. By intimately mixing theſe oils with their ſalts in a compound form, with a ſecret circulation, we obtain a ſecret ſuccedaneum for the alcaheſt; and again a ſuccedaneum even for the alcaheſt of *Helmont*, is obtained in theſe mixtures.

The uſe.

The doſe of theſe medicated liquors is principally determined from the power of the oil employed in them; the time for giving them is chiefly when the ſtomach is empty, and according to the nature of the diſtemper. For example, a ſimple tertian fever, very cold in the beginning, is to be cured after this manner. Two hours before the fit is expected, let the patient uſe a warm bath to his legs and feet, till he grows moderately hot, and afterwards take every quarter of an hour, half an ounce of the medicated liquor, prepared from the water, oil, and ſalt of wormwood; then let the feet and legs be well rubbed, and the whole regimen be continued till two hours after the fit was expected. And by this means all theſe caſes are generally cured with eaſe and ſafety, even in old age, unleſs there be any ſcirrhoſity or ſuppuration attending. So again, in the caſe of worms, a like preparation from tanſey being given for ſome time upon an empty ſtomach, proves excellent: but here, inſtead of the ſalt of tanſey, which is ſcarce, the ſalt of wormwood may be employed. Underſtand the like in other caſes.

PROCESS XL.

Odoriferous balſams artificially prepared from diſtilled oils, wax and pomatum.

'1. TAKE an ounce of perfectly pure pomatum, melt it in a china 'veſſel over a ſoft gentle fire, then gradually add a drachm of white wax,

'wax, fine ſhaved; and after the two are well mixed, remove the veſſel, 'and when they begin to thicken, drop in a drachm of eſſential oil, keeping 'the whole conſtantly ſtirring, that it may perfectly mix; after which ſet 'the containing veſſel in cold water, where growing immediately cold, it 'may keep in the oil and ſpirit. When the balſam is throughly cold, di- 'rectly put it up into boxes of lead, or pewter; which being cloſe ſtopped, 'it may thus be preſerved perfect for years. Inſtead of pomatum and wax, 'the expreſs'd oil of nutmeg may be here uſed, after it has been waſhed 'ſo long in water as to become white, taſteleſs, inodorous and pure; for 'this is the common way of preparing theſe balſams. If they are deſired 'of a grateful colour, this may be eaſily given them by the addition of a 'little pigment. Thus, for inſtance, a ſcruple of cochineal, reduced to fine 'powder, will tinge an ounce of the balſam of a pleaſing purple; or the 'ſame quantity of the inſpiſſated juice of buckthorn of a green; a little 'native cinnabar ground fine will turn it of a ſcarlet; fine turmerick of a 'yellow; or a little ſmalt of a blue. Any of theſe pigments therefore may 'be uſed at pleaſure, provided they have no ungrateful odour, or pernici- 'ous property.'

The uſe.

As theſe balſams are prepared in the way of rich perfumes; and in order to raiſe the languid ſpirits, the nobleſt oils, either ſeparate or artificially mixed, ſhould be uſed therein: and the principal of this kind are thoſe of baulm, calamus aromaticus, cinnamon, cedar, citron, cloves, jaſmin, lavender, white lilies, marjoram, mace, nutmeg, origanum, oranges, both thoſe of *China* and *Seville*, roſes, rhodium, yellow ſanders: to which we add balſam of *Peru*, and balm of *Gilead*; theſe two being ſpontaneouſly fragrant without diſtillation. The other oils fit for making theſe balſams are eaſily prepared extempore.

PROCESS XLI.

All meal and malt afford an unactive liquor, by diſtillation with water.

'MIX any kind of meal into a thin pappy conſiſtence with water, and 'diſtil it in a clean glaſs with a gentle fire, ſo as to prevent any 'empyreuma; whereby an indolent water will be obtained, without any 'inflammable ſpirit: then take the meal of malt, which we ſhall ſoon de- 'ſcribe, mix this in the ſame manner, and diſtil it with water; whereby 'again there will be obtained a ſpiritleſs liquor, which, as well as the for- 'mer, contains nothing that is acid, alcaline, oily, or ſpirituous: or if crude 'meal and malt be mixed together in water and then diſtilled, the pro- 'duce will be the ſame.

The uſe.

Hence it appears that no inflammable ſpirits exiſt in mealy vegetables before fermentation, not even after the operation of malting, which is a kind of

of dry fermentation. Neither does any nutrimental matter here riſe with the water, whoſe vapour forms drops like dew upon the glaſs ſtill-head, without running down in veins; the liquor alſo quenches fire, and when drank proves neither heating, nor inebriating, no more than refreſhing, or nouriſhing. And the proceſs holds of all meal, whether from grain or pulſe.

PROCESS XLII.

Honey diſſolved in water affords, by diſtillation, a water impregnated only with the ſmell of honey.

'TAKE one part of pure and perfect native honey, and ſix parts of 'pure rain water, mix them well together, and diſtil them in a 'glaſs veſſel with a moderate fire; the riſing vapour collects in watery 'drops ſcattered upon the inſide of the alembic-head, without running 'down in rivulets, tho' two thirds of the water be thus drawn off: nor 'has this water any vinous odour; but only that of the honey, which 'often retains the fragrance of the flowers, whence the bees collected it. 'All the water, which thus comes over, quenches fire, and upon drinking 'proves very inſipid, without heating, or inebriating.

The uſe.

Hence we learn that even the moſt elaborated juices of plants produced and perfected in the cells of flowers, and thence collected by the bees, contain nothing at all of that ſpirit which they afterwards yield by fermentation. Whence we clearly ſee that the action of the ſun upon the juices of plants, ſo long as they remain therein, can never produce the requiſite effect of a true fermentation; and conſequently that pure honey has not any heating, drying, or conſtringing virtue, but only one that is attenuating, detergent, relaxing, ſtimulating, and ſaponaceous: whence it has excellent effects both in chirurgical and internal caſes. And for this reaſon, ſcarce any thing was more celebrated by the ancient phyſicians than hydromel, or a mixture of honey and water; as being attenuating, aperitive, purgative, and ſtimulating, yet without heat: our honey-water, however, diſtilled in a *balneum mariæ*, receives a certain virtue from the ſpirits of the flowers lodged in the honey, and thence is accounted extremely uſeful in the way of *collyrium*, and fomentation, applied in inflammations or obſtructions of the eyes; as being in ſome meaſure the waters of the flowers that afforded the honey. Our preſent proceſs likewiſe holds in certain freſh expreſs'd and inſpiſſated juices of plants, as of manna, the pulp of caſſia, ſugar and tamarinds, which alſo, when mixed with water, and treated in the ſame manner, afford no vinous ſpirit. And the ſame holds of other thinner juices, as thoſe of berries, ſummer-fruits, the birch, the vine, *&c.* which, alſo, upon diſtillation, afford no inflammable ſpirit; ſo that the proceſs is univerſal.

The

The History of Fermentation.

There is ſcarce any thing more conſiderable in natural hiſtory, more common, or ordinary, in life, or more frequent in chemiſtry than fermentation; ſo that we may ſay, with the excellent *Bellini*, that all things are full of ferments. Eſpecially the chemiſts may ſay this; and *Helmont* affirms, that the virtue of ferments is the ſole cauſe of almoſt every tranſmutation: but talking too much in the general begets confuſion; for if every change proceeded from fermentation, then that word would be no more limited than the word change; whence the true difference of terms would be loſt. Hence ſome men of eminence have juſtly complained of this confuſion, and long wiſhed for a diſtinct treatiſe upon the ſubject, which I ſhall here endeavour to give.

1. By the word fermentation, I underſtand an inteſtine motion excited in vegetables, whereby they are ſo changed, that the liquor firſt riſing from them, by the force of fire in diſtillation, is either ſharp, miſcible with water, of a hot aromatic taſte, inflammable in the fire like oil, thin and volatile; or elſe ſharp, acid, capable of extinguiſhing fire and flame, leſs volatile and thin. This definition limits the term for fermentation; ſo as to comprehend whatever occurs in a real fermentation, without ſuffering the word to be applied to any thing elſe, which it leſs juſtly ſuits. There is at once an inteſtine motion in the whole maſs and all its parts, in every fermentation, ſo long as it continues: I call it inteſtine, becauſe it is chiefly excited by the internal principles contained in the vegetable. I allow there is ſomewhat here required, but this would not excite a true fermentation in the body, unleſs there was a diſpoſition thereto in the ſubject. For pure water, ſpirits, oils, or ſalts, being kept in the ſame heat, would never run into fermentation. I ſay this inteſtine motion can be excited in vegetables only, becauſe there has hitherto appeared no inſtance of fermentation in animals; unleſs where the animal had taken in vegetables, and not wholly converted them into its own nature; and for minerals I do not remember that any fermentative motion has been obſerved therein, tho' I know that ſome very eminent authors write as if there had. It is the office of reaſon to diſtinguiſh juſtly, and therefore I ought to define this operation from its effect; becauſe a true and perfect fermentation always terminates in the production of a ſpirit, or an acid, as we have deſcribed them. That there may be ſome iſſue out of this confuſion, I would aſk all the more prudent chemiſts, whether that action of vegetables, here deſcribed, is not termed fermentation? They ſeem all to allow it. I would again aſk, whether therefore the law of diſtinctneſs and order does not direct all thoſe actions, which produce not theſe effects, to be called by ſome other name? I think reaſon declares for it; and therefore tho' putrefaction be an inteſtine motion in vegetables, yet, as it affords putrid oils, and fetid volatile, alcaline ſalts for its laſt effect, I will throughly diſtinguiſh this operation from fermentation. So the putrefaction of the animal juices is alſo a true inteſtine motion, yet never produces acids, or inflammable ſpirits, but the matter of phoſphorus, and therefore differs

entirely from fermentation; for if it does not produce an inflammable or acid ſpirit, I ſhall avoid calling it fermentation for fear of confuſion. No more can the various effervеſcences, which we ſhall hereafter explain, be juſtly eſteemed as fermentation, tho' theſe alſo are inteſtine motions, and often happen in pure vegetable ſubjects, as in ſtrong vinegar, and fixed alcaline ſalt.

2. Any fermented vegetable liquor, that by diſtillation firſt affords an inflammable ſpirit, capable of mixing with water, I call wine, from whatever vegetable ſubject it is procured. And again, every vegetable liquor ſo fermented, as, in its firſt diſtillation, to afford an acid liquor, capable of extinguiſhing fire, I call vinegar, from whatever ſubject it was produced: ſo that the effect of a perfect fermentation will be either *wine*, or *vinegar* (*a*).

3. I call that a fermentable body, which may be ſo changed by the action above deſcribed *, as thence to produce either wine, or vinegar †. And as this was never found to happen in other than the vegetable kingdom, hence I am obliged to acknowledge, that vegetables alone are fermentable; and yet it will appear that all vegetables are not fermentable.

* See §. 1.
† See §. 2.

4. I call that body a *ferment*, which, when intimately mixed with a fermenting vegetable ‡, excites, encreaſes, and promotes the fermentation above deſcribed ‖: whence it appears that all ferments are of the vegetable kind.

‡ See §. 3.
‖ See §. 1.

5. The fermenting vegetables are extremely various; and are therefore to be diſtributed into ſo many claſſes, as they require different methods of fermenting; for we ſhould neither uſe more nor leſs of ſuch: thus as rye requires one treatment for the making of wine, and a freſh expreſs'd juice of grapes another; theſe two fermentable bodies muſt be diſtinguiſhed into two claſſes. On the other hand, as wheat, oates, and barley, require the ſame treatment as rye, theſe are not to be diſtinguiſhed between, but all reduced to one and the ſame claſs. In the mean while we muſt obſerve, that not all vegetables, but only certain kinds, are fit for fermentation; for thoſe above ſet down, under our thirty-third proceſs, abound with a copious, native, alcaline ſalt, or elſe are eaſily changed into it, and are therefore indiſpoſed to ferment, and apt to putrify. This I found by experience in onions and rape, from whence, when I firſt applied to chemiſtry, I hoped to have obtained by fermentation a ſpirit ſerviceable for the ſtone, but was fruſtrated in my expectation; for an alcaline, fetid, volatile ſalt, and a ſimilar ſpirit are afforded by theſe ſubjects, rather than one of the inflammable kind. Hence all fermentable bodies may undergo putrefaction, but not all putrefiable bodies undergo fermentation:

(*a*) The difference here laid down is arbitrary; and, perhaps, the author by admitting *vinegar*, as well as *wine*, for the criterion of *fermentation*, has in ſome meaſure defeated his own intention of limiting this operation: might not any one with as much reaſon add, that the affording of a volatile ſalt for the firſt thing in diſtillation, is the effect of another ſpecies of fermentation, called *putrefactive*, as that which produces vinegar is called acetous, or that which produces inflammable ſpirit is called vinous? Certainly this ſubject requires accuracy, and an extenſive knowledge of phyſical effects, before it can be juſtly ſettled.

mentation: ſo that in this reſpect there is a great difference between vegetables, as may be ſeen above in our thirty ſecond, and thirty third proceſſes.

6. Theſe things being carefully obſerved, we may range under the firſt claſs of fermentable bodies all thoſe ſeeds, which, when ripe and dry, may be ground into a fine meal, not an unctuous paſte; and to theſe we may add the ſeeds, which, tho' they abound with oil, yet may be ſo changed by art, as to be afterwards reducible to a leſs unctuous meal. We muſt therefore ſubdivide theſe mealy vegetables into three ſorts, *viz.* (1.) The ripe ſeeds, culmiferous, growing in ears, and having a graſſy leaf, uſually called grain, ſuch as barley, buck-wheat, millet, oats, rice, rye, wheat, *&c.* and other ſeeds, on account of their affinity, as flax-ſeed, canary-ſeed, the ſeeds of cucumbers, melons, pompions, lettice, *&c.* (2.) The ſeveral ſeeds of pulſe, as beans, cammoc-ſeed, *French* beans, heath-beans, lentils, lupines, peaſe, cicers, tares; with the mealy ſeeds of all other podded vegetables, which bear a papillinaceous flower. (3.) All the nuts, not over oily; as the almond, cheſnut, cocoa-nut, hazel-nut, horſe-cheſnut, piſtacho, walnut, *&c.* which if too rich in oil are firſt in ſome meaſure to be deprived thereof, as they may be by ſprouting and torrifaction.

7. The ſecond claſs of fermentable bodies contains all the pulpy ſummer's fruits, abounding with ripe, tartiſh, and ſweet juice; ſuch as apples, apricocks, barberries, citrons, cherries, currants, elder-berries, gooſberries, grapes, lemons, medlers, mulberries, oranges, pears, peaches, plums, raſberries, ſervices, *&c.* provided they tend not to a fetid alcaline putrefaction.

8. The third claſs contains the ſucculent herbs, and all their parts, as flowers, leaves, roots, and ſtalks, provided they rather incline to acidity, than putrefaction: whence thoſe exhibited under the thirty third proceſs are here to be excepted.

9. The fourth claſs contains the freſh expreſs'd, and native juices of plants, eſpecially of their fruits above ſet down*: to which may be added all the juices which diſtil from certain trees, when wounded, eſpecially in the ſpring, as the birch, the walnut, and the vine; for all theſe juices generally run into ſpontaneous fermentation, and then almoſt change their nature; and thus alter from cooling, acid, and ſtimulating, to heating, inebriating, and vinous. The elder *Helmont* recommends the water flowing by inciſion from the birch tree, as a ſecret againſt the ſtone, if uſed freſh, or after being kept perfect: Mr. *Boyle* confirms the obſervation by the experience of himſelf, and others; but found it had this virtue whilſt it remained recent, becauſe its nature was quite changed after fermentation.

* See §. 7.

10. The fifth claſs again contains thoſe vegetable juices, which are formed and inſpiſſated by nature, into a certain ſaponaceous ſubſtance, conſiſting of ſaline and oily parts; as honey, the pulp of caſſia, manna, ſugar, and all the other ſpecies of theſe juices, which are not balſamic, gummy, reſinous, or unctuous.

11. I have ſome doubt about making a fixth claſs of river waters; theſe indeed ſeem to be common lixiviums, impregnated with all kinds of vegetables that fall into, and reſolve therein, and thus at length become inti-

mately mixed. So likewiſe freſh fermenting vegetable liquors are diſcharged into the drains and ſluices of populous cities. If ſuch waters, therefore, be put into caſks, which before contained beer, wine, or vinegar, they may here for a long while conceal much ſpirit, and afterwards coming under the equator, or into the torrid zones, and feeling a great heat, they may be thus raiſed into a kind of fermentation (*a*). And under theſe ſix claſſes, I judge, that all the bodies capable of fermentation may be ranged, provided each be treated in the method it requires.

12. There are certain phyſical conditions requiſite, to render the ſubjects of the five former claſſes the fitter for fermentation, *viz.* (1.) A perfect degree of maturity, ſuitable to each kind; for all ſeeds and fruits which are ſo perfect, as when ſown in fertile ground at a proper ſeaſon, and in a proper climate, to produce a plant of their own ſpecies, are fit for this operation; but when they are crude, auſtere and watery, they are leſs diſpoſed thereto. Thus the immature and auſtere juice of grapes does not readily ferment, but the juice of ripe grapes preſently runs into fermentation; and the ſame generally happens in other ſubjects. (2.) Another requiſite to fermentation is a moderate proportion of oil; for fat ſubjects rather grow rancid than ferment, yet if entirely deprived of oil, they are thus alſo unfitted for fermentation. Thus bruiſed almonds, which are rich in oil, will ſcarce ferment; but may be made fermentable by grinding them well into an emulſion, with a large proportion of water: ſo again, when they are ſteeped with water, then made to ſprout, their oily part is thus much leſſened, and they made fitter for this operation. (3.) The ſubject muſt not be too auſtere or aſtringent, for then it would ferment with difficulty. Thus the juices of biſtort, tormentil, *&c.* will ſcarce undergo this operation. (4.) Solubility in water is a principal requiſite in a fermentable ſubject. Thus barks, roots, and woods, ſo long as they retain this form, do not ferment; but their expreſſed juices, now made capable of mixing with water, readily enter into fermentation.

13. The principal ferments are theſe, (1.) All thoſe things which of their own nature are greatly diſpoſed to ferment, ſo as immediately to begin this operation without any other ferment; ſuch as particularly the juices of ripe ſummer fruits, which are ſo ſtrongly diſpoſed to ferment, as ſcarce to be kept quiet without the help of things that prevent fermentation. So likewiſe a paſte made of flower and water, and laid in a warm place, cannot then be hindered from fermenting. Hence we need not be ſollicitous about a firſt ferment, becauſe nature ſpontaneouſly affords it every where. (2.) The recent flowers, thrown to the top of beer, in the act of fermentation; for if this rarified frothy matter be mixed with other fermentable liquors, it greatly promotes their fermentation, provided the flowers be freſh, and not ſhrunk, or fallen. (3.) The ſame matter now become heavier, and ſunk to the bottom, provided it be not too ſtale, ſtill retains the ſame virtue, tho' in a leſs degree than the former. In this ſtate it is called lees; and being by motion mixed with its own wine, it often occaſions a new fermentation,

(*a*) See theory, chap. of water.

and will excite it in other fubjects. (4.) Caffia, honey, manna, fugar, and the like infpiffated juices. (5.) Acid pafte of flower fermented, or bakers leaven: for tho' meal may be preferved, for years, frefh and fweet in a dry place, and kept from infects; yet if wrought with water into a foft fweet and clofe pafte, and lightly covered in a warm place, it will in an hour's time begin to heave, fwell, rarify, become all over full of cavities, change its fmell, tafte, and tenacity, prove acid both to the tafte and fmell, and thus become that proper ferment, which gave the original name of this whole operation: becaufe, when thus prepared, if a part of it be mixed with other frefh pafte, not yet fermented, it now caufes it to ferment much fooner and ftronger. Whence we have a quick way of preparing a ferment without the affiftance of a formal ferment. (6.) The remains of former fermenting matters fticking to the fides of the cafks; for cafks, every way penetrated by the fubtilty of the wines they before contained, become extremely apt for raifing a quick and violent fermentation in frefh liquors put into them. (7.) There might here be added, tho' fomewhat improperly, the white of eggs beat up to a froth, but in fome cafes this is requifite: for when the fermentable liquor is fo dilute and thin, as too eafily to let go and difcharge the air and fpirits which caufe and fupport the fermentation; or not to retain thefe a fufficient time for changing the nature of the liquor; the tenacity of the white of eggs here makes the liquor fufficiently thick to entangle the moving fpirits the due time. This therefore does not properly act as a ferment, for it would foon putrefy, but affifts the caufes of fermentation, by keeping them from exhaling too quick: and the fame end may be anfwered by other vifcous fubftances. (8.) Hence, alfo, both acid, auftere, and alcaline falts have been efteemed ferments, as being ufeful in certain cafes; as where the fermentable matter was too acid to ferment kindly; for in this cafe, by a prudent addition of a little alcali, the operation may eafily be promoted. Again, if any thing putrefiable fhould arife in the fermentable fubject, the fparing and careful addition of an acid may reftore the loft power of fermenting: whence it appears that thefe things are not ferments in themfelves, nor indeed fermentable, but become affiftant by a particular quality only, or by removing the obftacle of the operation. Tartar, however, if it be good, may in fome refpect be called a ferment. (9.) Laftly, it is obferved, that very auftere bodies being added to thofe which are lefs fermentable, fometimes procure, and in other cafes hinder fermentation. Hence, quinces, auftere cherries, unripe medlers, and the like are referred to the clafs of ferments; but this is properly done only when the fermentable liquor is of itfelf too dilute, thin, and broken, fo as to require fome aufterity to fit it the better for retaining the volatile fpirits.

14. We now proceed to confider thofe preparations which the better fit fermentable bodies for fermentation. The fubjects, therefore, enumerated under the firft clafs, require a particular previous preparation. (1.) Thus the ripe, dry, and perfect mealy feeds are firft fteeped in rain-water, efpecially in the fpring feafon, in large veffels, and warm weather, and here left fo long till they have imbibed as much as they can of the water, and are grown plump and fwelled therewith. (2.) Being now taken from the water, the

the grain is thrown into a large heap, in an open place, a little expoſed to the wind, where an impregnating heat ſoon riſes, and by means hereof the vital parts of the ſeeds are excited, rendred active, and begin to ſprout, ſhooting forth their little ſeminal leaves, and firſt rudiments of roots; at which time caution muſt be uſed to prevent the heating maſs from beginning to putrefy, and again, from ſprouting too long, and ſhooting into leaves and roots, which would conſume the mealy ſubſtance: for the fermentation always proceeds the better, the more exactly this ſprouting is performed, which ought to be neither too much nor too little. (3.) As ſoon therefore as the ſprouting is ſufficiently come forwards throughout the whole heap, the grain muſt immediately be ſpread abroad ſomewhat thin, to prevent its continuing hot, as it would do in a large heap; and that it may be thus expoſed to the air, and be dried and cooled by admitting the wind in at the open windows, eſpecially the north wind. By this means the farther ſprouting is preſently ſtopped, whilſt the mealy part remains attenuated, but not conſumed by this action; and being now ſuffered to run ſlowly thro' a metalline trunk, conſiderably heated, it is thus ſuddenly dried, or very moderately ſcorched, or roaſted, and is now called malt; or in the language of *Tacitus*, *frumentum corruptum.* The change, which here happens to the grain, is principally this, that its viſcidity is ſo far attenuated, that whereas wheat will not diſſolve in hot water, malt will give out a large part thereto, or ſuffer its meal to diſſolve therein: and thus crude wheat being chewed in the mouth becomes a glue, that can ſcarce be attenuated by the continued action of maſtication; but when the wheat is malted and chewed in the ſame manner, it readily diſſolves in the mouth. Malting alſo procures an agreeable and very ſweet taſte, which the wheat had not before. A little before this malt is uſed, it is ground into a coarſe meal, called by the name of ground malt; and what we at firſt ſaid of wheat holds of all the ſeeds abovementioned, in our firſt claſs of fermentable bodies; for if beans be made turgid with ſteeping, then ſuffered to ſprout in a large heap, and afterwards immediately dried with a great heat, and then ground, the phænomena, and effects will be the ſame (*a*).

15. The ſubjects of the ſecond claſs are prepared by preſſing, ſqueezing, or bruiſing the ſoft or pulpy ſubſtances, ſo that their fermentable juice may come out; but if they are more fleſhy and hard, they may then be boiled in water, and ſo become a ſoft pulp, as is often done in pears and apples: but if the ſubject be dry, ſtrong and tough, let it be raſped, bruiſed with water, and ſo brought to a pulp, as in tuberoſe, and other bulbous roots, not apt to putrefy.

16. The ſubjects of the third claſs are to be bruiſed, whilſt freſh and juicy, to a pulp along with ſo much water, as may make the pulp thin, and ſufficiently dilute; and this is all the preparation they require.

17. If the ſubjects of the fourth and fifth claſſes are too thick of themſelves, they require to be diluted with ſuch a quantity of water that the liquor may ſupport a freſh egg; but if theſe ſubjects are too thin or weak, and a well fermented liquor be required from them, the juices,

(*a*) See Philoſoph. Tranſact. N° 142. p. 1096. and *le Fevre, de la fermentation.*

while

while they are fresh, and before they have suffered fermentation, must be boiled over a gentle fire, in a wide and shallow vessel, till they acquire the requisite thickness, otherwise they would scarce ferment, or afford much spirit. But when they are too thick, they are to be let down with water, to the standard above-mentioned, otherwise they scarce afford any spirit. Dry sugar remains unchanged in the hottest air; but if brought to the thinness of fresh cream, it ferments violently, and becomes a liquor exceeding full of spirit (*a*): and the same holds of honey, *&c.*

18. We are next to consider what quantity of ferment is requisite to be added to the fermentable bodies abovementioned, when prepared for fermentation, that the operation may succeed the better. And here we are first to observe, that the preparations of the first class, when reduced to malt, scarce require any ferment in the summer, but then spontaneously, and sometimes too strongly fall into fermentation; but in the winter they require the addition of some ferment, and the assistance of heat to make them ferment quick. If therefore they are kept in a warm place in the winter, they require less ferment, and for this purpose a small addition of yeast is sufficient; *viz.* an ounce to twenty pints, or the same proportion of honey or sugar, or twice the quantity of baker's leaven. The subjects of the second class scarce ever require any ferment, unless the weather be too cold; and if the fermentation proceeds slow on this account, let a little yeast be added. The subjects of the third class also readily ferment in the summer, if the weather prove hot; and in the winter, if the fermentation languishes, it may be quickened by the addition of honey or sugar, as was sufficiently shewed under the seventeenth process. The subjects of the fourth class very seldom require any ferment, and in hot weather can seldom be kept from fermenting, or moderated therein, especially when the heat is great, and the fruit well ripened. The subjects of the fifth class also require no ferment, as being rather ferments themselves: they only require an artificial heat to be raised, and kept always equally to the same height; whence we learn, that ferments are seldomer required than is commonly imagined.

19. After any of these fermentable bodies, therefore, have been so prepared, and properly diluted with water, in the manner above-mentioned, let them be put into a cask of oak, where the like liquor before had first finished its fermentation; so that the cask may remain well impregnated therewith. Set it in a place where the heat is raised between sixty and seventy degrees, and leave the bung-hole open, that the air may freely enter and come out again; or only cover it with a linen cloth, to keep insects from falling in.

20. If we take very large glass bodies, and place them upright in a wooden chest, so that they may be kept in an equal heat, by means of a little fire placed below, and then three fourths of them be filled with a crude fermentable matter, well prepared for the operation, the orifice being slightly

(*a*) I suppose the author has his eye upon the syrups: which will sometimes ferment violently in hot weather; but to make a solution of sugar or honey, so strong as is here mentioned, is not the way to obtain a wine or a spirit to advantage in any moderate time, unless a great degree of heat be used.

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covered with a cloth, and a heat between ſixty and ſeventy degrees, kept up even in the winter ſeaſon ; it will be pleaſant to obſerve the ſeveral appearances of fermentation, and which always obtain, and may be obſerved in the following manner. (1.) The whole maſs at firſt reſting, and poſſeſſing a certain ſpace in the veſſel, gradually begins to ſwell, riſe, rarify, and conceive an inteſtine motion thro' its whole body, acting upwards, downwards, and ſideways, in ſtrange circumvolutions, without ceaſing, tho' with a different force: in the mean time, bubbles being every moment formed in every part of the maſs, and conſtantly endeavouring to riſe up, where they burſt with an hiſſing noiſe, and often break in the mid-way. Hence the whole maſs froths, eſpecially on the ſurface, whilſt at the ſame time there is diſcharged, with an audible ebullition thro' the whole body, a certain ſharp and tartiſh ſpirit, that proves acrimonious to the noſe, ſurpriſingly elaſtic, uncapable of being confined, and capable of burſting almoſt any veſſel by its great exploſive force ; in which reſpects, no other liquor, ſo far as I know, can be compared therewith. And hence the great *Helmont* thought proper to give it the name of wild *gas*. (2.) In the progreſs of this action, all the fermentable groſſer matter of the maſs begins to riſe at the top, and ſeparate from the other liquor below, ſo as to collect into one thick ſpungy cruſt, exactly covering the liquor underneath, keeping in the more active parts thereof, and returning them downwards ſo as to prevent their exhaling, and being diſſipated before they have performed their effect. And now it is pleaſant to ſee how great an agitation there every where conſtantly is, even in the leaſt parts of the whole fluid matter, below the tenacious cruſt already deſcribed ; certainly, a greater attrition can ſcarce be conceived, than that here made with the utmoſt rapidity among all the corpuſcles ; and hence the cruſt being ſucceſſively broke, and raiſed upwards, with a conſiderable noiſe upon the returns of the exploſions, the exhalations eſcape, whilſt the cruſt, preſently falling together, cloſes again, and prevents the active principles from otherwiſe exhaling : and thus the formation and continuance of this cruſt is highly aſſiſting to the due performance of fermentation. (3.) In the mean time, as ſoon as all the groſs fermentable parts of the mixture are thus collected at the top, ſome leſs rarified parts of the lower part of this cruſt, being no longer ſuſtained by the light bubbles, which occaſion them to aſcend, they begin again to ſink thro' the fluid, and are agitated upwards and downwards, form bubbles in and about themſelves, and, by means thereof, are again raiſed to the top, where the bubbles breaking, they again fall downwards ; and when they have done thus for ſeveral times reciprocally, theſe parts at length remain quiet at the bottom ; and after this, new little maſſes do the ſame ; ſo that after ſome continuance hereof, it frequently happens that the whole upper cruſt, now growing heavier, or leſs rarified, on account of the ſpirits diſcharged, ſinks of a ſudden downwards, but ſoon after rolls upward almoſt entire, with a ſurprizing and ſcarce credible force, unleſs it were ſeen. And now after the whole upper cruſt is entirely conſumed, and fallen to the bottom, the fermentation ceaſes, tho' the ſame degree of heat be continued ; at which time the liquor become tranſparent, thin and light, floating over the fæces remaining

ing at the bottom. (4.) Hence in every true fermentation, the fermentable matter is firſt always uniformly mixed, then ſeparated into two parts, or a thinner fluid below, and a thicker cruſt at top. This cruſt at top, ſo long as it remains there, is called the flowers of the fermentable matter, and is one of the moſt proper and immediate ferments. Next, in the ſecond ſtage of fermentation, the liquor is ſeparated into three parts, *viz.* the flowers, a middle fluid, and a matter beginning to fall, and collect at the bottom, called fæces, or lees; being the more groſs and ponderous part, exhauſted of all the principles that occaſion fermentation. Thirdly, In the laſt ſtage of fermentation, the matter is again ſeparated into two parts; the upper, a clear, thin, pure liquor, called wine; the other a groſs matter, lying at the bottom, called lees, or the mother of wine. (5.) There is nothing more extraordinary in this fermentation, or that deſerves more carefully to be obſerved, than the ſurprizing wild ſpirit, which violently breaks out in the ſtrength of the operation; as I do not remember that ſo immediate, mortal, and ſubtile a poiſon has been hitherto diſcovered; for if a large veſſel, full of the beſt fermenting muſt, now in the height of its action, ſhould diſcharge its condenſed ſpirit thro' a ſmall orifice made in the upper part of the caſk, and a ſtrong healthy man ſhould draw in at his noſtrils the vapour collectedly iſſuing out thereof, he would inſtantly fall down dead, without any diſtemper; or if he received but little thereof, become apoplectic; or if ſtill leſs, he would remain an ideot his whole life, without common ſenſe, or become paralytic. And the ſame accidents befal thoſe, who imprudently remain long in ſuch wine-vaults, where wines are fermenting in the vintage ſeaſon, if the vaults remain ſhut up. For which reaſon they are obliged to air theſe places, by ſetting open the windows, lighting a fire, and admitting the wind, as is every where well known. It is alſo related, that a ſpirit has been drawn from ſugar, and the ſcummings thereof, firſt diſſolved in water, and then fermented; which ſpirit being received in a very ſmall quantity into the lungs, inſtantly ſtopped all reſpiration, and gave an intolerable aſthma (*a*). Hence phyſicians ſhould conſider what effect ſuch liquors may have in the body, as are drank in a ſtate of fermentation, or that ſpirit which in the ſummer ſeaſon is generated in a hot body, by too free an uſe of ripe ſummer fruits, if prevented to eſcape by any convulſion, or conſtriction of the ſtomach: whence theſe fruits would acquire and exerciſe a violent elaſticity and acrimony in ſo warm a place. And hence a conſiderable quantity of this poiſon ſtill remains in ſpirit of wine, the vapour whereof, when long and largely received at the noſe, produces a high degree of inebriation, which is but a lighter apoplexy; and if drank too freely, it principally hurts the brain, the nerves, and their functions. In the mean time, it is uncertain whence this ſpirit proceeds: it is doubtleſs the creature of an active and immediate fermentation, nor do we know that the ſame thing is produced by any other cauſe. We cannot underſtand how it ſhould occaſion death, without cauſing any diſeaſe, or producing any apparent alteration in

(*a*) See Philoſ. Tranſ. abridg. *Lowth.* vol. II. p. 635.

the brain, *cerebellum*, nerves, juices, or ſolids. As ſoon as the fermentation is finiſhed, it is proper to cloſe the veſſel, and let the fermented liquor ſtand for ſome time upon its lee; a great part thereof will thus be conſumed, and aſſimilated by the liquor, which will now become ſtronger, and richer in ſpirit, than before, eſpecially for the uſe of diſtillation.

21. The time required for the perfect finiſhing of fermentation can ſcarce be exactly determined, as being different in different places, and according to the ſeaſons of the year, the difference of heat, winds, and the ſubject itſelf. The juice of the palm-tree in *Africa* finiſhes its fermentation in a few hours time. In *Aſia* likewiſe this operation is preſently over; but in the northern countries it proceeds ſlower. In the heat of ſummer it proceeds quick, but in winter more languidly. It is promoted by the ſouth wind, and retarded by the north. The juice of grapes and ſugar ferment with a ſudden violence, but other things more ſlowly. It is however eaſy to know when the fermentation is finiſhed, *viz.* when the whole ſeries of the phænomena above deſcribed, has ſucceſſively appeared, and is at length ſpontaneouſly gone off; at which time the veſſel is immediately to be ſtopped down, and the fermented liquor kept upon its lee; otherwiſe the ſpirit produced in the fermented liquor, would ſoon exhale, and leave a vapid uſeleſs fluid behind: but if the liquor be kept quiet, in a well cloſed veſſel, it gradually becomes more ſubtile, pure, and ſpirituous. Thus the freſh expreſs'd juice of grapes may be inſpiſſated by boiling without diminution to its virtue; but when fermented and expoſed, even to a cold air, it preſently loſes all its ſpirit.

22. The liquor thus obtained, by a perfect fermentation, has, in all ages, amongſt all nations, and in every language, been called by the name of wine, from whatever ſubject it was made: but the common nature of all wines is known by the following ſigns. (1.) It has the faculty of inebriating, or altering the actions of the ſpirits, and animal functions, by exciting, refreſhing, animating, and exhilarating the perſon, diſpoſing to mirth, eloquence, poetry, and dancing; at length it raiſes the latent paſſions, diſcloſes ſecrets, afterwards diſturbs, weakens, and deſtroys the external and internal ſenſes, and voluntary motions; ſo that neither the hands, the feet, the tongue, or the mind, can now perform their office; and thus it brings on ſleep, the palſy, the apoplexy, and at laſt death itſelf. And this is eſteemed the peculiar virtue of wine; nor am I hitherto acquainted with the like property in any other ſubject. For the caſe of henbane, tobacco, opium, and thorn-apple is very different, when they affect the brain. And this virtue is nearly the ſame in all wine; for malt-liquor, mead, cyder, perry, the wine of gooſe-berries, grapes, and other berries, have always the ſame effects, when properly made; ſo that this ſurprizing power is peculiarly owing to the efficacy of fermentation alone. (2.) This operation alſo changes the relaxing, reſolving, ſaponaceous, cooling, and generally purging virtues of vegetable juices, into ſuch as are ſtrengthning, coagulating, drying, and heating. Thus all farinaceous ſubjects mixed with water, into a thin pappy maſs, the freſh infuſion of malt before fermentation, hydromel, ſyrups made with ſugar, a ſolution of manna, or the pulp of caſſia in water,

water, the recent exprefs'd juices of ripe fummer fruits, and the ripe fummer juices of fermentable plants; all of them, when plentifully drank, prove flatulent, cold, purgative, and weakening; but when properly fermented into beer, mead, and wine, they have quite contrary virtues, or an entire new fet which they had not before. Thus the rich juice of perfectly ripe grapes is a violent diffolver of the animal juices, and, when drank immoderately, often occafions a mortal bloody-flux. The infpiffated decoction of malt, when plentifully drank, has the fame effect; but make the former into a ftrong old wine, and the latter into a ftrong old beer, or diftil a brandy, or fpirit of wine from them both, and thus remedies are obtained for the preceding diforders. (3.) It is a very peculiar property of this fermentation, that it produces, from the fermented liquor, a certain fpirit which is convertible into lucid flame, and yet may be perfectly mixed with water. This fpirit is of a very different nature from that wild one above defcribed, which feems to be generated in the act of fermentation, but afterwards loft. The fpirit, we here fpeak of, has fcarce any where its equal; for the volatile inflammable one, which I formerly faw, with no fmall danger, burft from the retort, in the diftillation of phofphorus, could not be diluted, and extinguifhed with water; and that which flies off from human excrement, long kept in a large quantity, and in a clofe place, where the matter is highly putrefied, and which upon the approach of a candle turns into a violent and dangerous flame, feems indeed of the fame nature, but is intolerably fetid. So again, when oily matters, diftilled with the utmoft violence of fire, afford white bluifh fumes, thefe alfo catch flame upon the approach of a candle, but return to oil or phofphorus, that will not mix with water: fo that, when all things are well confidered, I do not hitherto know a liquor that will abfolutely, and, as it were fpontaneoufly, mix with water, and at the fame time remain convertible into pure flame, except this one produced by fermentation. (4.) We have already explained in our eighth procefs, the manner of procuring tartar, tho' this is not afforded by all forts of wine, nor even the beft malt liquors, nor mead, and many other forts of wine; but from whatever vegetables it is obtained good and pure, it is only thus produced after the wine has perfectly finifhed its fermentation, and is become throughly fine and bright. And hence I always efteemed tartar as the production of fermentation, and think proper to call it the effential oily falt of wine; with care to diftinguifh it well from the lees of wine. (5.) There is here a furprizing change of the fmell, tafte, native and medicinal virtues of the fubject, as appears by comparing our fixteenth and feventeenth procefs together; for the cohobated water of rofemary differs extremely, and in every refpect, from that prepared by fermentation with honey. The frefh exprefs'd juice of ripe *Rhenifh* grapes has a very fweet tafte; but when perfectly fermented, and fuffered to reft in the cafk, it taftes gratefully tart and pungent. Other wines, not perfectly fermented, but ftopped before the operation is fully ended, remain fweet; but then eafily fall back into a new fermentation, and, when that is finifhed, turn four. *Aloes* and *Coloquintida* are obferved by *Wedelius*, to lofe their bitternefs upon

 fermentation.

fermentation (*a*). I my felf have produced very pure fpirits from malt-liquors, mead, cyder, wheat, and grapes, and conceive no difference could be found between them. (6.) This new odour, tafte, and virtue may be properly called vinous, and is generally attended with a tartifh, heating, unctuous property, along with fomething of the malt, honey, or fugar. (7.) Thefe fpirits are produced, either from a matter before of a very different nature, or elfe from the oil of the fubject: the latter feems very probable, but then it may be afked, what oil it is? Chemifts generally fay from the effential oil; but I do not perceive by what experiment they prove it: for the prefiding fpirit, which conftitutes the effential oil, is loft in the fermentation; befides much oil remains in the matter after it is fermented, and even after it is diftilled for its fpirit; but I could never bring the remainder to ferment afrefh, nor by any art produce any more fpirit from it. So that in every fermentable fubject there is only one determined part fit for producing fpirit, and that only in a certain quantity, by fermentation and diftillation; and it is impoffible to procure more. But this alfo muft be confidered, that pure white-wine, when the fermentation is perfectly finifhed, produces a white tartar, which is full of a perfectly inflammable and penetrating oil, tho' no inflammable fpirit, fuch as wine plentifully affords, can by any chemical experiment be drawn from it; whence it appears, that the matter convertible into this fpirit by fermentation, is perfectly peculiar, whilft yet an immenfe quantity thereof is continually generated, confumed by animals, or exhaled into the air by the fermentation which produces thefe fpirits, and which is now every where practifed. But the *faliva*, blood, and urine of the animals, that daily take in thefe fpirits, fcarce afford any by diftillation; and yet there is no where any want of frefh matter to produce them, by the help of fermentation: this deferves to be well confidered. Fermentation alfo produces fomething faline, as appears by the acid, which is confiderably volatile, tho' lefs fo than the fpirit; for a volatile, acid, and unctuous falt, is produced in vinegar, which did not appear in the matter before it was fermented. The fpirit alfo acquires fomewhat of this volatile acidity in the fermentation; hence the oils and falts of fermentable fubjects feem to be fubtilized, volatilized, united and confumed in a certain proportion in fermentation. For if rofemary, without being fermented, is diftilled with water, it affords an oil, having the true fmell and tafte of the plant, and a white water impregnated with the fame virtues; but if fermented with honey, and diftilled before the fermentation is finifhed, it affords a white water, thick, opake, and unctuous, rich in the virtues of the rofemary, with fome oil, tho' lefs than before, fwimming on the water. Laftly, if the fermentation be perfectly ended before the matter is diftilled, it affords a pellucid fpirit, that mixes with water, and abounds in the medicinal virtues of the plant, whilft no oil of the effential kind any longer appears. (8.) The fpirit produced by fermentation, participating of an oily nature, becomes more volatile than water; whereas the effenital oil, before the fermentation, was not fo volatile

(*a*) See *Acta Lipfienf.* 1686. p. 366.

as

as water; but the vegetable, by means of a gentle heat, might be deprived of all its water, without ſuffering any oil to riſe at the ſame time.

23. The things that promote fermentation, or tend to the better performance thereof, are theſe; (1.) Reſt in the fermenting maſs, that the ſkin, formed on the top, may remain unbroken; for if this were to be continually ſtirred in, and mixed among the other matter, the effect of fermentation would not be produced. (2.) A free admiſſion and emiſſion of the common air, which alſo requires to be intimately mixed in the ſubject, either by treading, kneading, or preſſing; and without this admiſſion the fermentation will ceaſe. (3.) The warmth before directed, *viz.* that between ſixty and eighty degrees at the moſt. (4.) It is ſaid alſo, that the ſpring and autumn favour the operation, whilſt the plants flouriſh, which afforded the wine; and hence wines are ſaid to grow eaſily ropy, and ferment afreſh in theſe ſeaſons.

24. The things which check or hinder fermentation are chiefly theſe, (1.) The acid fume of burning ſulphur, received in a large quantity at ſeveral times, and ſhut up along with the air, remaining on the top of the fermenting liquor. For if the whole caſk be firſt penetrated, and filled with the fumes of burning brimſtone before the fermenting liquor is put in, and then the empty part on the top be well filled with the ſame, and the veſſel now cautiouſly bunged down, the fermentation will be ſtopped; and if after ſome time it ſhould begin again from the prevalency of its own cauſes, it may again be ſuppreſs'd by the ſame fumes. And the ſame end is obtained by mixing a large quantity of any powerful acid with the fermenting matter, as the acid ſpirits of alum, nitre, ſalt, ſulphur, or vitriol; tho' theſe at the ſame time ſpoil the fermenting liquor. (2.) Alcaline ſalts, alſo, if added in a large quantity to fermenting liquors, immediately excite a greater effervescence, which preſently ceaſing, all farther fermentation is ſtopped. But here alſo the fermenting liquor is ſpoiled, ſo that it can ſcarce again be brought to ferment, tho' it may to putrefy; and hence it appears that alcalies reſiſt fermentation, more than acids, by ſuffocating, or changing the nature of the whole acid part. (3.) And hence all thoſe things which deſtroy acidity by drinking it up, hinder fermentation, after a ſhort effervescence, if mixed therewith in a proper quantity: thus chalk, coral, crabs-eyes, pearl, teſtaceous ſubſtances, iron, lead, and tin have this effect. (4.) The ſtopping up of the containing veſſel ſo cloſe, that nothing may eſcape or enter, provided the veſſel be ſo ſtrong as not to burſt by the force of the confined liquor. This is manifeſt in new malt-liquors, which when included in ſtrong bottles, well ſtopped down, and afterwards receiving the air, for ſome time excluded, it turns the fermentation into a violent effervescence, which exerts a very great force: and the ſame is every where found in caſks; for the fermenting liquors, and the ſides of the containing veſſel, mutually act upon, and preſs each other. (5.) Too great a degree of cold likewiſe ſtops all fermentation, which can ſcarce go forward with leſs than thirty ſix degrees of heat. (6.) Too great heat, which if it exceeds ninety degrees, rather diſſipates and throws off the active principles of fermentation, than excites and promotes them; whence a ſtrong exhalation, performed with a greater heat, renders the fluid ſo thick, as perfectly unfits

unfits it for fermentation. But boiling has this effect much fooner; fo that the moft perfect juice of grapes, that could not be kept from fermenting, lofes by quick boiling all its difpofition to fermentation, and afterwards remains a quiet mafs, unchanged for years. (7.) The extraction of the elaftic air, by means of the air-pump; in which ftate none of this motion is exerted. (8.) And laftly, a violent compreffion of the fame air, with the fermentable matter, entirely prevents the origin, and ftops the progrefs of fermentation.

25. When the liquor is perfectly fermented, it fhould be put up along with its flowers and lees into very clofe and well filled veffels, and fuffered to ftand for fome time in a cold quiet place, where having thus produced more fpirit, the whole becomes fit for diftillation; in order to which, the liquor is by motion to be mixed along with its lees, becaufe it thus affords much more fpirit; but then care muft be taken in the diftillation, that the lee does not faften to the bottom of the ftill, and there fcorch and burn, fo as to make the whole empyreumatical; it is therefore to be kept moving with a ftick till it is ready to boil, whereby the lees will be equally mixed among the liquor, and the great heat, by its motion, prevent the feparating of the thicker parts from the thinner: and thus all the fpirit may be advantageoufly obtained both from the liquor, and the lee, without danger of burning. And if the fermented liquors be fuffered to reft for fome time before diftillation, there will be lefs danger of their boiling over; but when committed to the ftill, as foon as the fermentation is over, the remaining force of the late fermentation often carries up the boiling liquor with violence, and fo difturbs the whole operation; for which reafon the operator muft proceed cautioufly at firft.

26. The following particulars tend to prevent burning. (1.) The fides and bottom of the ftill may be fmeared over with fome unctuous matter before the liquor is put in. (2.) The whole may be kept continually ftirred till the heat begins to mix it, and thus by the motion prevent the thicker part from falling and fixing to the bottom. (3.) Nothing more effectually prevents this burning than the previous boiling of a little water ftrongly in the ftill; and whilft this is in hand, immediately pouring in the liquor to be diftilled; for the hot vapour, filling the cavity of the veffel, prevents the fermented matter from fticking to the fides.

27. If, according to this direction, the whole fermented matter, with its flowers, clear liquor, and its lees, be thoroughly mixed together, and then diftilled, a perfect fpirit will be obtained.

28. When the matter is almoft ready to boil, its firft violence is to be guarded againft, for which purpofe one third part of the ftill muft be left empty, and the mouth of it covered with a thin linen cloth to be kept fixed by the head; then the fire is to be fo regulated, that one drop of liquor may juft follow another, by which means the diftillation will proceed with fafety; and being kept up for fome time in this manner, it may afterwards be fomewhat increafed with caution, fo as commodioufly to raife all the fpirit; but the thinner and clearer liquors, fuch as mead, wines, and old malt-drinks, do not require fo much caution; but all mealy fubjects, diftilled immediately

mediately after fermentation, require the utmoft care : the former therefore may from the firft be diftilled, fo as that the fpirits may run in an almoft continued ftream from the worm.

29. Whilft the operation is performed, in the manner above defcribed, the liquor that firft comes over proves fharp in the mouth, heating, pungent, of a particular tafte, called by the name of fpirituous, and extremely penetrating. It is alfo highly fluid, and volatile, fo that few liquors are known to exceed it therein, or fcarce any befides the pure alcaline fpirit, the fmoking fpirit of tin, *Glauber*'s fpirit of nitre and fea-falt, and true volatile alcaline falt. When this liquor is ftrongly heated by fire, it readily takes flame upon the approach of a candle, and burns nearly all away ; it occafions drunkennefs, ftupefaction, and the apoplexy ; but in a fmall dofe wonderfully raifes the fpirits ; by its heat, it prefently cures punctures, lacerations and pains in the nerves ; it preferves from putrefaction all vegetable and animal bodies that are put into it, only changes their colour a little. If a little pure fugar be diffolved in it, before it is perfectly free from all its phlegm, it makes a limpid liquor, that preferves the tendereft fubftances. If it be diluted with water, and applied in the manner of a warm fomentation, with a litte fal-ammoniac and vinegar ; there is fcarce any thing better for refolving coagulations, difcuffing tumours, ftopping gangrenes, feparating the putrified parts, and drying up the humours that run off too faft. It is called fpirit of wine.

30. If when all this fpirit is come over, the remainder be urged with the fame fire, in the fame veffels, there follows a lefs volatile, acetous, acid, aftringent, cooling, naufeous and foul liquor, leaving at the bottom a thick feculent matter, which can never after, by any art, be brought to ferment again, nor to afford any more fpirit, tho' from its thicknefs, one might eafily expect it fhould ; and if this remaining mafs be treated with a ftrong fire, it affords a fetid empyreumatic oil.

31. If all the feculent matter be dried, and afterwards burnt in a naked fire, it affords faline afhes, from whence a fixed, and fomewhat alcaline, or truly alcaline falt, may be obtained ; after the fame manner as under our fifth, fixth, ninth, tenth, twelfth, and nineteenth proceffes ; whence it is plain, that the moft perfect fermentation cannot volatilize that matter of vegetables, which is fixed by burning in the fire, and which might be converted into effential falt, according to the feventh and eighth proceffes.

32. This is a fhort and true hiftory of fermentation, delivered in a chemical manner. I have fo far explained its fubjects, affiftants, impediments, caufes, manners, actions and effects, that, perhaps, there is no other phyfical action fo clearly and diftinctly defined, and fo accurately feparated from all others, as this is. Hence, I prefume, the reader will beware of confounding this action of nature, with any other different from it, to prevent a confufion of terms, and thence of doctrine. And thus medicine will be freed from fo many and trifling fictions of the effects of imaginary ferments, wherewith the half learned chemifts, have difturbed and oppreffed it. Thus the phyfical hiftory of animals and foffils will be purged from fo many opinions of fermentations ineffectually introduced, as being an operation never performed

performed there. It ſeems only to begin in the firſt paſſages of animals deſtined for the production of the chyle, and in ſuch creatures as are ſupported by fermentable foods and drinks; but ſoon after breaks off on a ſudden; tho' in a few diſtempers it may perhaps be continued farther, even thro' the inteſtinal cube. The great maſters in alchemy have alſo been too licentious, and wandered too wide from one or two reſemblances, till they declared that metals fermented. Every operation in arts ſhould be ſtrictly limited by its individual properties, which conſtitute the peculiar nature of the action; for thus, upon barely hearing the mention of the effect, the attentive mind immediately underſtands what ought certainly to happen. Let us uſe the utmoſt caution to prevent confounding this operation with effervеſcences, ebullitions made by the fire, or the putrefaction of vegetables or animals; of which hereafter.

PROCESS XLIII.

Meal and malt mixed with a proper quantity of water, and fermented.

HAVING laid down the general doctrine of fermentation, we proceed to deliver certain examples, that ſhew the manner wherein nature and art proceed. There are therefore two ways of working, the firſt whereof prepares a drink, or wine, from corn, and thence a ſpirit of wine; the other directly produces a ſpirit from fermented corn, as it is uſually produced from malt liquors.

'The firſt manner is this; they pour hot water upon ground malt, mix 'them well together, and let them ſtand to infuſe warm for three or four 'hours, by which means the malt impregnates the water with its flowery 'part, contrary to what the meal of natural corn would have done. The 'infuſion, being now drawn off from the remaining malt, is boiled up to 'the requiſite thickneſs; this decoction has an emollient, laxative, purg-'ing, cooling, antiphlogiſtic virtue. If, after it is cooled, and ſet in a 'warm place, a proportion of ſtrong yeaſt, or lees, be added to it, and the 'veſſel be kept open at top, there ariſes a violent fermentation, which be-'ing finiſhed, and the liquor directly ſtrained cold, thro' a cloth into a 'caſk, that is afterwards cloſely bunged down, it thus becomes excellent 'malt-drink; but to make it keep the longer, a certain quantity of the 'bittereſt herbs is boiled therein, which prevents its turning ſour. If the 'decoction be made ſufficiently thick by boiling, moderately impregnated 'with the bitter plants, perfectly fermented, and kept in well-cloſed caſks 'ſet for a long time in a vault, and be afterwards diſtilled, there firſt comes 'over as excellent a ſpirit of wine, as can be obtained by art from any real 'wine; as proving extremely fragrant, and without any ungrateful odour. 'And this I have by experience found, that ſuch a kind of malt-drink 'ſcarcely differs from the moſt generous wine; and have wondered, that 'in all the ages, of which we have any notice, it ſhould have been known

'and

'and ufed. *Diodorus Siculus* (*a*) fays, that King *Ofiris* taught a way, where 'wines are wanting, of preparing a drink from barley, not much inferior 'to wine in fragrance, and pleafantnefs. *Herodotus (b)* fpeaks of a beer, or 'wine made from barley. *Tacitus (c)* of barley or corn fteeped or prepared, 'fo as to refemble wine. And *Aetius (d)* fpeaks of barley fteeped till it 'fprouted, then dried along with its fprouts.

'The fame operation is performed in the common method thus. Take 'fourteen pounds of the flower of malt, and feven pounds of rye flower, 'mix them very well together, for a confiderable time, with hot water, till 'the liquor becomes moderately thin; then pour it into an oak cafk, and 'fet it into a wooden cheft, as formerly mentioned, that it may be kept 'in a warmth equal to that of fummer; it will thus ferment ftrongly, and 'fhould ftand till the cruft form'd at the top, during the fermentation, be 'fallen to the bottom; then clofe the veffel, and leave it fo for fome time, 'by which means the liquor above will be clear, and tartifh; whilft a large 'mealy mafs will be found at the bottom, tho' not clammy, but fit for 'diftillation.'

PROCESS XLIV.

Honey diluted with water, and fermented.

'DILUTE honey with fuch a proportion of rain-water, that the folu- 'tion may fupport a new laid egg on its furface; this is called hy- 'dromel. Fill an upright cafk with it, fo as to leave the tap-hole, which 'is now at the top, open; place the cafk in the wooden cheft, and keep it 'conftantly heated to feventy degrees. The liquor will foon begin to fer- 'ment, with all the figns of fermentation; let it continue thus till the ope- 'ration is entirely over, when the liquor will have a fweet fpirituous tafte, 'and is to be kept in a clofe veffel, under the title of mead, or metheglin.

PROCESS XLV.

Malt and meal fermented, as in the forty-third procefs, afford an inflammable fpirit, and a vinegar, by diftillation.

'POUR a pint of boiling water into the ftill, light up the fire, that the 'water may continue ftrongly boiling, then pour in the malt and 'meal fermented according to the forty-third procefs, after they have by 'fhaking been well mixed together, leaving a third part of the ftill empty; 'the fire is now to be increafed, and the matter kept frequently ftirring 'with a ftick, to prevent the groffer part from adhering to the bottom, and 'to continue the mafs well mixed. When almoft ready to boil, clap on the

(*a*) *Diodor. Sicul.* l. 1.
(*b*) *Herod.* in *Euterp.* ζυθος, οἶνος ἀπὸ κριθῆς γινόμενος.
(*c*) *Tacit. de morib. German.*
(*d*) *Aet.* βύνη, &c.

'ſtill-head, and carefully regulate the fire, ſo that the head may grow thoroughly hot, and the ſpirit may diſtil ſufficiently quick thro' the worm; and thus a limpid, thin, ſpirituous liquor will be obtained. As long as this continues to run, let it be kept ſeparate under the title of malt or corn-ſpirit: after all this is come over, there follows a tartiſh, unpleaſant, nauſeous, white liquor, which has nothing ſpirituous, or hot to the taſte, and if farther urged, begins to ſmell fetid.

'This firſt liquor is that we before deſcribed, in the hiſtory of fermentation, under the title of ſpirit, produced by fermentation.'

PROCESS XLVI.

Mead prepared by fermentation, according to the forty-fourth proceſs, affords an inflammable ſpirit, and a vinegar, by diſtillation.

'TAKE mead prepared according to the forty-fourth proceſs, and long kept in a cloſe veſſel; and diſtil as above: tho' as this is leſs flatulent, or exploſive, it requires leſs caution than the former. An excellent ſpirit of wine will firſt come over, not to be diſtinguiſhed from that of real wine; and the time it continues to run muſt be obſerved, that this ſpirit be kept ſeparate. When it is all come off, if the receiver be changed, another watery, white, ungrateful liquor will follow.'

The uſe.

Theſe two proceſſes afford examples of the diſtillation of ſpirits from fermented liquors, together with the proper cautions required. The groſs, mealy matter remaining behind, as alſo the remainder of the mead after the ſpirit is drawn off, ſtill contains ſomething nutrimental; and the caſe is the ſame in beer. But if this matter be artificially treated, according to the proceſs of fermentation, it cannot be made to ferment again, but it will grow ſour and vapid, without turning vinous ſo as to afford freſh ſpirit: and thus it gradually corrupts more and more.

PROCESS XLVII.

The rectification of the ſpirituous liquors produced by fermentation.

'TAKE any fermented ſpirits that have been once diſtilled, and draw them over again, leaving one third of the ſtill empty, and obſerving to regulate the fire ſo as to make the liquor gently boil, or a ſlender ſtream to run from the worm: and thus a limpid, thin, and fragrant liquor will firſt ariſe, having the taſte of ſpirit. Let the receiver be often changed, in order to taſte whether the ſame ſpirit continues to come over, and keep on working ſo long as it does. The ſpirit, thus produced, is to be carefully kept

'ſeparate,

'separate, and put up in a close glass, under the title of rectified spirit of 'wine; and here it is certain, that what comes off first is always the best. 'When therefore the tartish, white, and more aqueous liquor begins to 'come, this must be kept separate under the title of phlegm, and not mixed 'with the former; it usually comes over in great plenty, and contains but 'little spirit. There yet remains, at the bottom of the still, a gross, opake, 'unctuous, acid liquor, of an ungrateful smell; but as to the rest perfectly 'aqueous, in respect of spirit. If this liquor was left upon the distillation 'of pure brandy, it is always red, and has a somewhat austere taste; both 'the colour and the taste being principally owing to the wood, or cask, in 'which such brandies are usually preserved; for they extract the resinous and 'oily parts from the wood, and have not this colour, taste, and odour, 'when first distilled, but are then perfectly pellucid; and acquire these pro-'perties by their lying in the cask, and lose them again by rectification.'

The use.

Hence we understand how these spirits may be so purified, as to be procured almost alone, or unmixed; and the oftner the rectification is repeated, the more pure they become; as always leaving behind some watery, acid phlegm, upon each repetition; whence they constantly become more pure and simple, tho' they still retain some water.

Hence we learn also, that brandies always consist of some different kinds of parts; for they contain a pure spirit, the product of fermentation, which we shall shew how to exhibit alone in the following process. Secondly, a pure water, which may likewise be separated from them alone, as in the two following processes. Thirdly, a certain acetous fermented acid, which also rises in the first distillation of spirit of wine, and remains strongly cleaving thereto, but is exactly separated from it in the following forty-ninth process. Lastly, a small quantity of a certain ill-scented oil, which always manifests itself, when rectified spirit of wine is poured upon dry fixed alcali, or when the spirit is drawn from that salt by distillation; whence it has happened that chemists, sometimes, little attending to these particulars, and often employing the common spirit of wine, have met with phænomena they did not expect: and these phænomena are often unjustly attributed to the spirit; whilst they are rather owing to the other things mixed therewith. Such phænomena may be owing to other causes; but the spirit is to be ascribed to fermentation alone. Some considerable chemical authors, observing that an acid almost constantly accompanied these spirits, have wrote that the spirits themselves were acid, and generated from an acid. But if the thing be rightly considered, it may perhaps appear otherwise; for when these pure spirits are distilled from fixed alcaline salt, they are totally deprived of all manifest acidity, yet are still excellent and genuine. I allow they are only produced from vegetables, that first turn acid by fermentation, but not that the spirits themselves are acid, though produced from a tart substance; whence we cannot truly say of them, that they are either acid, or alcaline, but of their own peculiar nature. And the spirit, rectified to the utmost perfection in this manner, will still remain compounded.

PROCESS XLVIII.

Alcohol produced from the ſpirits gained by fermentation, according to the forty-fifth, forty-ſixth, and forty-ſeventh proceſſes, without addition.

'LET any ſpirit obtained by fermentation, eſpecially ſuch as has been ' once rectified, be diſtilled with a gentle fire, from a tall narrow glaſs- ' body, in the little furnace deſcribed in the chapter of furnaces, till one ' half be come over: and here the heat ſhould not be raiſed higher than a ' hundred degrees. Let the half, which firſt comes over, be diſtilled again ' from a clean veſſel, and repeat the operation till the half remaining in the ' glaſs-body appears as ſtrong as that which came over. A ſpirit, thus ob- ' tained, is that uſually called alcohol of wine, and is accounted perfectly ' pure, without any foreign mixture, even ſo much as of phlegm. The ' ancient artificers uſed the ſame method but in different furnaces (*a*). But ' the exactneſs of later chemiſts has found, that ſome water ſtill conſtantly ' remains concealed among it; whence many experiments, requiring the uſe ' of perfect alcohol without water, have proved unſucceſsful: but as the ' labour of procuring ſuch a ſpirit was extremely tedious, induſtry has diſ- ' covered a ſhorter way of obtaining alcohol in purity.

' A kind of furnace was made for a bath-heat, that could not admit a ' greater heat than of 214 degrees; and herein a large ſtill was placed, and ' common ſpirit of wine poured into it, ſo as to fill two thirds thereof; ' the ſtill was now fitted with a head riſing in a tall, upright, ſlender pipe, ' which, bending at the top, came down and fitted into the worm. The ' diſtillation, here, is ſo performed, that the water of the bath coming to ' boil, makes the ſpirit of wine boil ſtronger; whence the ſpirit alone being ' able to riſe ſo high from the fire, and thro' ſo ſlender a pipe, continues to ' diſtil as long as any remains in the liquor; and when all the ſpirit is come ' over, the phlegm will not riſe, but the diſtillation then immediately ceaſes. ' And thus, at a ſingle operation, we may, in the compaſs of two or three ' hours, obtain as much ſpirit as by the former method we could in almoſt ' a month: and therefore no chemiſt can be without this furnace, who re- ' quires a large quantity of alcohol in his operations (*b*). Yet upon carefully ' examining the matter, I find that even thus a little water will ſtill remain ' mixed with the alcohol, being in the diſtillation raiſed therewith. Hence ' I have repeated the operation, and re-diſtilled the alcohol by itſelf in this ' ſame furnace, whereby I obtained an alcohol that appeared pure, almoſt in ' every reſpect, tho' even this contained ſome little water. Whence I con- ' ceive, that the ſpirit, by this method, can never be perfectly ſeparated ' from the phlegm, tho' it is but a very ſmall quantity that is here left behind.

(*a*) See the collector of the chemical menſtruums, concerning the method of procuring the philoſophical ſpirit of wine.

(*b*) See the conſtruction of this furnace, in the chapter of furnaces.

' After

'After this therefore I took the alcohol prepared by diftillation in this 'furnace, and half filled the ftill therewith; then adding half a pound of 'pure decrepitated, hot and dry falt, I put on the head, carefully clofed 'the junctures, and left them thus together for twelve hours, in a heat fo 'fmall, as by no means to make the alcohol boil. Then I diftil'd off the 'fpirit, and kept the firft two ounces apart, becaufe fome little aqueous va'pour might happen to lodge in the pipe of the ftill or worm; and this al'cohol of the firft running will eafily wafh it off. I afterwards received 'two thirds of the following alcohol in a pure dry glafs veffel, and kept it 'perfectly well ftopped; then I drew off the remainder as before, and kept 'this by itfelf: there remain'd a moift falt in the ftill, which had attracted 'the water from the alcohol, and held it fo down, that it cold not rife by 'the heat of boiling water, fo as to come over with the alcohol. And the 'falt thus prepared never changes the alcohol by communicating any thing 'thereto; becaufe it is firft decrepitated, and employed hot: and by this 'means I can in this furnace readily prepare a perfectly pure alcohol for all 'chemical ufes.'

The ufe.

1. The alcohol thus perfected, is the lighteft of all fluids next to the air, extremely pellucid, thin and fimple, totally inflammable without fmoke, and without leaving any fæces behind; it has no difagreeable fcent in the burning, remains the fame after diftillation, is very expanfive with heat, eafily boils over the fire, is of a very grateful odour, and of a particularly grateful tafte; it inftantly coagulates all the juices of the body, except pure water and urine; it hardens the folid parts of the body, and preferves both the folids and fluids from putrefaction, or fpontaneous refolution; it preferves the bodies of infects, fifhes, birds, and other animals, fufpended in it, perfect for ages; it mixes almoft uniformly with water, vinegar, any acid liquors, oils, and pure volatile alcaline falts; it diffolves gummy and refinous bodies: whence we are acquainted with no liquor, either natural or produced by chemiftry, that will mix with more bodies. It is in particular an excellent vehicle to the prefiding fpirit of vegetables, as by means of alcohol, it may commodioufly be extracted from its own body, and be ufed for medicinal and other purpofes. The capital chemifts, who are accounted adepts, are fuppofed to have fhadowed out the preparation of the fecret of the philofopher's ftone in the artificial preparation of this perfect alcohol: and certainly this alcohol owes its origin to fermentation alone, and cannot otherwife be prepared.

2. In the live human body it wonderfully raifes, gratefully affects and ftirs the animal, natural, and vital fpirits, the nerves and the brain, by its odour, tafte, and exhalation; whence it increafes and enlarges the ftrength, the fenfe and agility; and thus by various degrees, at length, occafions drunkennefs, which both comes on, and goes off fuddenly. It inftantly coagulates the blood, the ferum, and other juices; whence, when imprudently drank, it is faid to have inftantly killed the drinker. Externally applied, it dries, ftrengthens the veffels, and coagulates the juices in them, where it reaches, by infinuating itfelf. It in a moment dries up and contracts the extremi-

ties

ties of the nerves, which it touches, and deprives them of all ſenſe and motion; whence it appears how imprudently, and often unſucceſsfully, alcohol is uſed, either pure or impregnated with aromatic ſpirits, and heated, for a fomentation; or rubbed into the parts externally, for chirurgical purpoſes, with the addition of camphire, or the like diſſolved in it. Caution muſt therefore be here uſed; for inſtead of the ſpecious titles of vivifying, heating, reſtoring mobility, reſolution, and diſſipation, the effects will be ſuch as we have above deſcribed. In wounds, likewiſe, and in ulcers, the application of pure alcohol has the ſame effect, by coagulating, drying, and burning up the nerves, which it eaſes of all pain, but at the ſame time deſtroys their uſe. It inſtantly ſtops bleeding by contracting the veſſels, and coagulating the blood it touches, but then alſo it has the effects above mentioned; and hence it becomes a ſudden, and often a powerful remedy, in theſe caſes, tho' always attended with danger.

3. Hence we underſtand what the effects of pure alcohol are upon the parts of animals, and plants, ſuſpended in it; for if they contain any thing oily, the alcohol will diſſolve it, and extract it from the matter, which therefore becomes ſhrunk, diminiſhed, and often wrinkled: and hence the prepared parts of animals often appear thus changed. Aromatic flowers, leaves, and roots are affected in the like manner; but ſmall birds with their feathers on, and little animals covered with hard ſcales, are exactly preſerved by being plunged in hot alcohol; becauſe the ſhrinking, if any ſhould happen here, is not ſo eaſily perceived; and when they have been ſteeped for ſome time in pure alcohol, ſo as to be thoroughly penetrated therewith, and then dried in a ſlack oven, and afterwards ſuſpended in glaſſes cloſe ſhut, ſo as perfectly to exclude the external air, they may thus be preſerved for ages, to the unſpeakable advantage of natural and medicinal hiſtory, becauſe they will thus leave us ſpecimens, whereby the things may be known.

4. Since therefore chemiſts and other artiſts require the pureſt alcohol on numberleſs occaſions, ſo that if the leaſt drop of water remain in it, the experiment would fail of ſucceſs, we ought to have ſome certain marks whereby to diſcover when this alcohol is perfectly pure. Theſe marks are chiefly the following, (1.) If the alcohol contains any oil diſſolved therein, it immediately turns milky upon the addition of water, and lets go the oil. (2.) If it contains any acid, when a little of the alcohol is mixed with the ſpirit of *ſal-ammoniac*, the effervesſcence thereupon will ſhew, that an acid is preſent, otherwiſe a ſimple coagulation will remain; and if any thing alcaline be concealed in the alcohol, this will be manifeſt by the effervesſcence that the addition of an acid will occaſion. As for other ſalts, they are ſeldom contained in alcohol. (3.) It is more difficult to diſcover whether any water be concealed therein; whence the chemiſts have invented certain ways of trying it: the firſt whereof is repeated diſtillation, from whence they expected to obtain the ſpirit pure without phlegm: but I have obſerved, that I could never by this means obtain it ſo. A ſecond way, therefore, is to fire ſome of the alcohol heated in a ſpoon, and ſuffer it to burn in a ſtill place, where no wind is moving; and if after the burning, no moiſture remained in the ſpoon, they pronounced the alcohol pure. But being made more cautious by

by the means of other experiments, which we ſhall ſoon relate, they obſerved that the water alſo, concealed in the alcohol, might at the ſame time, by the action of the flame, be carried into the air; and conſequently, that this was a fallacious proof. In the third place, therefore, they took dried gunpowder, and laid a little of it in the bottom of a dry ſpoon, then pouring the alcohol upon it, they heated it, and ſet it on fire, and ſuffering it to burn out in a quiet place, if at laſt the gunpowder became dry, and took fire, they judged the alcohol to be pure. But this trial alſo is apt to deceive as well as the former; both which, tho' they ſhew the alcohol contains but little water, yet do not ſhew that it contains none: therefore in the fourth place, the ſureſt trial of all is to take a round chemical four or ſix ounce vial, with a long and ſlender neck, and filling two thirds thereof with the alcohol, add thereto a drachm of pure dry and hot ſalt of tartar, ſhake them well together, and hold them over the fire, ſo that they may heat a little leſs than ſuffices to make the alcohol boil, and if when thus heated and ſhook they leave the ſalt of tartar perfectly dry, we may be ſure that the alcohol contains no water, or if any, not to be diſcovered by any experiment hitherto known, unleſs by the water collected from the flame of alcohol entirely burnt, of which experiment we have ſufficiently treated above (*a*). At leaſt when I have mixed this alcaline ſalt with alcohol, allowed to be pure, I have immediately diſcovered whether it contained any water; for upon taking alcohol that would burn entirely away, and fire gunpowder, yet ſalt of tartar being added, and growing moiſt therein, preſently ſhewed that ſuch alcohol contained water. Again, upon adding a drop or two of water to the alcohol, wherein the fixed alcali had long remained dry, the ſalt immediately grew moiſt, and appeared to run unctuous upon the ſides of the veſſel. Hence therefore the peculiar nature of alcohol is ſufficiently determined by its own invariable properties; eſpecially if we add, that ſuch alcohol diſtilled in a glaſs alembic gives no ſigns of itſelf, as neither like water appearing in moiſt drops, nor like good ſpirit of wine running in veins, but remains inviſible; which was known to the ancient chemiſts, as appears by their writings. And this is the ultimate limit of fermentation; becauſe this alcohol can ſcarce be further perfected or changed.

PROCESS XLIX.

Alcohol prepared with alcalies.

'BECAUSE a large quantity of pure alcohol is often wanted of a ſudden, 'when the chemical apparatus is not at hand, and when it is not detrimental if the alcohol ſhould contain any fixed alcali; the induſtry of the 'chemiſts has diſcovered this method. Take a clean glaſs-body, containing 'common ſpirit of wine, and add thereto one third of its weight of pure 'and dry pot-aſh, which immediately falls to the bottom, ſhake the glaſs

(*a*) See the articles, Fire and Menſtruums.

'and the ſalt immediately grows moiſt, and begins to diſſolve at the bottom, whilſt a thin, red liquor floats above it: the more the veſſel is ſhook, the more liquid the lower part of the ſalt becomes, and the more diſtinctly ſeparated from the upper liquor; nor is it ever poſſible to mix them together, but upon reſting they will immediately ſeparate into two diſtinct maſſes. The leſs water the ſpirit contained, the more there will be of the upper liquor, and *vice verſâ.*

'Let theſe liquors reſt for ſome time, that they may exactly ſeparate from each other, then pour off the upper liquor, by a gentle inclination of the veſſel, into another clean and dry veſſel; with care to prevent any of the other liquor from falling in. Have in readineſs another parcel of fixed alcaline ſalt, well dried at the fire, and put it hot into the glaſs-body containing the former ſpirit, now decanted, and deprived of its water; ſhake them together in the glaſs kept ſhut, and the ſalt that was put in dry will again become ſomewhat wet; continue to ſhake them ſo long till the ſalt appears to diſſolve no more, but a tranſparent red liquor floats above it, which will be obtained the purer, the drier and hotter the alcaline ſalt was, and the longer the ſhaking was continued. After this, pour off the liquor into a tall and dry chemical vial, and put to it a little extremely dry, pure and hot fixed alcali; ſet them together in a place heated to a hundred degrees, and frequently ſhake the vial; if the ſalt now remains perfectly dry, the alcohol will be pure, but of a red colour, a mixed taſte, and a ſomewhat ungrateful odour; it will alſo give manifeſt ſigns of its containing an alcali by its lixivious taſte, and making an efferveſcence with acids. In this operation there always appears ſome fat oil, which ſeparates itſelf, either from the ſpirit, or the pot-aſh, or perhaps from them both; and this oil has an unpleaſant ſmell: the fixed alcali likewiſe here employed, changes its nature, and by uniting with the acid contained in the ſpirit, at length becomes a compound, and ſomewhat volatile ſalt. Hence I have found that this ſalt being ſeveral times uſed for the ſame operation, and each time dried again, at length changed as it were into the nature of *terra foliata tartari*; or at leaſt became unfit for farther ſervice as a fixed alcali: whence we have a confirmation of what was above ſaid, of the nature and parts of common ſpirit of wine. If the alcohol, thus prepared, be once diſtilled with a gentle heat, in a glaſs veſſel, it will be obtained ſufficiently pure, and not unfit for all the operations that require a perfect alcohol; ſomewhat however of an alcaline nature remains in it, and may be deſtroyed by carefully adding a few drops of the oil of vitriol, before the diſtillation, till no more efferveſcence appears, after which the alcohol will be obtained pure by diſtillation.'

The uſe.

Hence we learn that the procuring of pure alcohol proves more difficult than is commonly thought; becauſe ſomewhat acid and aqueous remains intimately mixed with it in the diſtillation: and by uſing of fixed alcali, this alſo cloſely unites with the ſpirit; whence we need not wonder, that many elegant

elegant experiments, requiring the ufe of fimple alcohol, fhould fo feldom fucceed. It is alfo manifeft, that fixed alcali will fit the alcohol for certain experiments, either becaufe it feparates the water, acid, and oil; or becaufe it adds fomething of its own alcaline nature, and fo increafes its diffolving power. All thefe particulars, therefore, are to be regarded before we can determine of the fuccefs or failure of any experiments wherein alcohol is ufed. Chemiftry, therefore, having produced alcohol, is come to its utmoft limits in this particular; as being unable to perfect the production farther, refolve it into more fimple parts, or even to change its nature. Upon a careful examination I found, that the moft limpid fpirit of wine, rectified in the common manner, by one diftillation, and poured upon pure falt of tartar, divides itfelf into two parts, fometimes nearly equal; one whereof is pure water, and the other pure alcohol, as is fufficiently known; but I never could find, upon making many experiments, that true fimple alcohol, united with pure fixed alcali, would mix one half, or its oily part, with a faline alcaline fubftance in form of a balfamic foap, called the *Samech* of *Paracelfus*, and leave its other half mere elementary water. This however is afferted by the great *Helmont* (*a*), and indeed it fucceeds in the manner I mentioned above; but not as the followers of *Helmont* affert, *viz.* that he here joined the fulphur of the wine with the fixed alcali: for in my experiments the water joins with the falt, and rejects the alcohol fo long as any water remains therein; whereas they fay that the oil of the alcohol unites with the falt, and rejects the water. But more of this fubject in our *eightieth* procefs, where fome laborious experiments, performed to this purpofe, will greatly illuftrate the matter; and nothing more of this kind is here required.

PROCESS L.

The origin of vinegar.

HAVING feen the effect of the firft fermentation, *viz.* the production of alcohol, we come next to confider the production of the fecond, *viz.* vinegar, which can never be had genuine, without a previous, and indeed a double fermentation; for wine muft firft be made, before vinegar can be procured. And again, every wine is difpofed to become vinegar by art, that is, if the wines be mixed in, and ftirred with their own lees, flowers, and tartar reduced to powder, as alfo the acid and auftere ftalks, fkins, hufks, and leaves, that contain a tartarous falt, and the whole be fet in a warm place, contained in a wooden veffel, efpecially fuch as has been feafoned with the fume of vinegar, and in a place alfo abounding with a vapour thereof: for thus the wine begins a new fermentation, and produces a confiderable degree of heat, in which refpect the acetous feems to differ from the preceding vinous fermentation. And if the vinous fpecies fhould be too long continued, the wine will grow four and flat, but never become good vinegar, to make which requires a particular and exact operation.

(*a*) Page 58, 86.

The remote matter, therefore, of acetous fermentation is every vegetable ſubject fit for vinous fermentation, provided it be firſt properly changed into wine by means of the vinous fermentation: but the immediate ſubjects for preparing of vinegar are wines of all ſorts; this rule being obſerved, that the ſtrongeſt wines afford the ſharpeſt vinegars, and *vice verſâ.*

The proper ferments for promoting this operation are chiefly theſe, (1.) The lees of tart wines. (2.) The lees of vinegar depoſited in the old caſks, eſpecially, if ſaturated with the ſharpeſt vinegar. (3.) The tartar of acid wine reduced to powder. (4.) Vinegar itſelf perfectly prepared, and brought to a high degree of acidity. (5.) Old caſks which have long lain filled with the ſharpeſt vinegar, ſo as to become penetrated with the ſharp acid thereof. (6.) The frequently repeated mixture of the lee with its own wine. (7.) The ſtalks, huſks, and ſkins of cherries, currants, grapes, or the tendrels, and the like parts of the vine, that are acid and auſtere. (8.) Bakers leaven, after it is turned acid. (9.) All the compoſitions of the former, eſpecially with the addition of keen aromatics; for then the vinegar, hence produced, will become exceeding ſtrong.

Glauber has long ago exactly deſcribed the hiſtory of the operation in his writings againſt *Barner*, and it was afterwards publiſhed in the Philoſophical Tranſactions. The method in ſhort is this.

'Take two large open veſſels, made in the manner of common hogſheads, 'in each of them place a wooden grate, within a foot of the bottom, as 'they ſtand upright; upon theſe grates firſt place a moderate layer of the 'green twigs, or cuttings of the vine, and upon this the ſtalks of the grapes, 'without the ſtones, till the whole pile reaches within a foot of the tops of 'the veſſels, which are to remain open; then fill one of theſe veſſels with 'wine to the top, and only half fill the other; then with liquor drawn 'out of the full veſſel, daily fill up that which was only half full before, 'and do this alternately, without ever leaving a full veſſel above twenty-'four hours. Thus on the ſecond or third day there will ariſe in the half 'filled veſſel the motion of fermentation, with a ſenſible heat, which gra-'dually increaſes every day; and in the full veſſel, the motion and heat is 'at the ſame time checked, ſo as almoſt to ceaſe upon that day: and thus 'fermentation and heat ceaſe and renew alternately, firſt in one veſſel, and 'then in the other. The operation muſt be continued, till at length the 'heat is extinguiſhed, and the motion ſtopped in the half filled veſſels; 'which is a ſign that this acetous fermentation is perfectly finiſhed. The 'vinegar thus prepared is to be kept in caſks cloſely ſtopped.'

The uſe.

The hotter the place is wherein the vinegar is made, the ſooner the operation is performed; and in *France* it is finiſhed in fifteen days in the ſummer, but in winter, and in a cold place, it requires much longer time; and in the heat of ſummer, or if the place be extremely hot, the vinegar often requires to be ſhifted from the full veſſel into the half full one every twelve hours, otherwiſe ſuch a heat and fermentation would be raiſed in the half

filled

filled veſſel, as to diſſipate the volatile ſpirit of the wine, not yet ſufficiently fixed, before it was fixed and changed into the acid ſpirit of vinegar; and thus the vinegar would become vapid, and no way like that which is found and good; and for this reaſon the half filled veſſel is always kept cloſe ſtopt with a cover, that the ebullition of the liquor may be checked, and that the ſpirit, being kept in, may the longer and more powerfully act upon the auſtere body, and be entangled by its re-action. And theſe covers are to be made of the ſame wood; but the full veſſel is always left open, that the air may have free acceſs to change the liquor.

This is the ſecond fermentation that tends to, and terminates in the making of vinegar; which is unjuſtly taken for a liquor produced after the loſs of the ſpirit of the firſt fermentation; for in that caſe the liquor would be a vapid thing, and not vinegar: but the more generous and ſpirituous the wine is, the better vinegar it affords in this operation, and the weaker, the worſe. And hence good malt-liquors, treated in the ſame manner, make excellent vinegar; and the ſame holds true of rich *Spaniſh* wine. We muſt here obſerve that this fermentation, which converts wine into vinegar, is attended with a conſiderable heat, whereas fermenting muſt, in the time of the vintage, is ſcarce warm, and fermenting beer, notwithſtanding its violent motion, is not ſo much as warm; whence it ſhould ſeem that heat is always required to generate acidity. Milk and meats prepared of bread, flower, *&c.* require a heat of ſome kind or other, to turn them ſour; the violence of the fire turns the neutral bodies of nitre, ſalt, and ſulphur, into very ſtrong acids. If we conſider this, we ſhall ſee that almoſt every thing requires its peculiar heat.

Another thing to be here conſidered is, that whilſt wine acquires the nature of vinegar in the manner above deſcribed, tho' the wine was thin and limpid, it depoſites an incredible quantity of a groſs, fat, oily, or ſoapy matter, which all around gradually grows to the ſides of the caſk, and the ſkins and twigs employed. From whence ſhould this proceed? There are no ſigns of it in the wine, the twigs, or the rape; yet it is thus generated from the wine, becauſe if waſhed away, more is produced by the wine; and this unctuous groſs matter ought to be removed once a year, otherwiſe the wine put into the caſks would not be changed to vinegar, but into a corrupt, groſs, unctuous liquor, unfit for any uſe. Therefore all the rape, now turgid with the ferment of the vinegar, is ſuddenly to be waſhed from this unctuous matter, by paſſing water quick thro' it, leſt by remaining long in the water, the acid virtue of the rape ſhould be drawn out; ſo likewiſe the grate, the ſides and bottom of the vinegar caſks, are to be cleanſed with the ſame caution, and again fitted for the operation as before; and thus they ſerve again, till by a long continuance of converting wine into vinegar, the ſame unctuous cruſt ſhews, that the wine does truly throw off an oil, whilſt it paſſes into vinegar; and that the acetous ferment does remain in the caſk, the grate, and the rape: whence this power becomes very great in the old caſks of this kind, which, together with all the parts belonging to them, at length become a kind of ſpunges full of vinegar.

We muſt, laſtly, remember what was obſerved above, that alcohol prepared from old ſtrong beer is undiſtinguiſhable from that afforded by the beſt wine; and the ſame holds true of vinegar, which, being made from the ſtrongeſt old beer, proves as good, pure, and uſeful for any purpoſe, as that made of the beſt wine. Nor can any difference be eaſily found betwixt them, unleſs ſo far as the bitters employed in making the beer may give it a different taſte and colour, and ſomewhat alter the nature of this from that made of malt alone: and hence we may be ſufficiently certified of the action of this ſecond fermentation, which, when perfectly performed, is the production of good vinegar.

That this action, however, may be the better underſtood, we proceed to conſider what vinegar is; and we ſhall find it a vegetable, acid, penetrating, ſomewhat unctuous, and volatile fluid, produced from wine, by the action above deſcribed, the firſt part whereof that comes over in diſtillation is truly acid, and no way inflammable, but like water quenches fire and flame; which wonderful properties accurately diſtinguiſh vinegar from wine. Wine is prepared by the firſt fermentation directly from vegetables, and vinegar by a ſecond fermentation from what was wine before. The firſt part that comes over from wine by diſtillation is readily inflammable, but the firſt part obtained from vinegar by diſtillation extinguiſhes flame like water; and therefore there is a particular difference between them. Some of the moſt ſkilful among the chemiſts have ſaid, that vinegar is the volatile tartar of wine, becauſe tartar is the moſt acid part of wine, tho' not volatile; and vinegar a converſion of wine into an acid that is volatile: and again, becauſe wine generally depoſites a tartar, but vinegar none, tho' it ſtands long, whilſt yet being deprived of a great part of its oil in the making, and ſo become more acid, it ſhould ſeem ſo much the more diſpoſed to generate tartar. It is true, that what remains at the bottom, after the diſtillation of the vinegar, ſeems to reſemble tartar, but yet, upon due examination, it will appear very different from it, as we ſhall ſee in the fifty-firſt proceſs. But it is of great moment to chemiſtry, medicine, and all philoſophy to underſtand the nature of this vinegar. And, (1.) it is a liquor already deſcribed by its characters, to which we may now add, that it is a volatile, oily, acid ſalt; for its oil, tho' wonderfully concealed under a thin and hungry acid, will hereafter be manifeſted by many evident experiments, eſpecially under the ſeventy-ſixth, and hundred and ſeventy-third proceſſes. This compoſition is extremely uſeful, as reſiſting putrefaction, which is ſo common and ſo dangerous to the animal juices, and at the ſame time has its acrimony mitigated by the oil united with it. It is alſo ſo penetrating, as without a ſeparation of different parts, to paſs expeditiouſly thro' the denſeſt ſubſtance, without loſing its virtue: nay it will freely paſs almoſt thro' the whole body, except a few ſmall veſſels, and therefore may be diſtributed into all the larger, and exerciſe its proper virtues therein, eſpecially as they will be there excited by the vital motion and natural heat. It alſo eaſily mixes with all the juices of the body, not excepting even oils themſelves; and by means of its thinneſs and diſpoſition to mix, it produces many effects in the body. It has an extraordinary cooling virtue in fevers that ariſe from an acrimony

of

of the bile, or any alcaline ſalt, or putrid matter generated in the body; as likewiſe from the bites of venomous creatures; and allays the thirſt occaſioned thereby: whence *Dioſcorides* and *Hippocrates* have commended nothing more highly in theſe caſes, than a mixture of vinegar and water, eſpecially when mollified by the addition of honey. And chirurgeons know of nothing more efficacious in external diſorders, ſuch as the *eryſipelous* inflammations, and putrid ulcers; and for the cure of venomous bites, there is nothing more effectual, than this liquor of honey and vinegar, as we remarkably find in the bite of a mad dog. It is ſo oppoſite to drunkenneſs, that whereas ſpirit of wine is almoſt the only thing which occaſions that diſorder, the ſpirit of vinegar removes it. Nay, a perſon almoſt dead drunk by the abuſe of ſpirituous liquors, may be brought to himſelf by the drinking of vinegar; ſo that nothing ſeems more fitted to move the ſpirits, and excite the nerves, than this. When I have often endeavoured in vain, by elaborate chemical productions to relieve perſons in weakneſs, faintings, lethargic, drowſy, and vomiting diſorders, I have at length effected it by means of vinegar, applied to the noſe and mouth, or received into the ſtomach; and what is ſcarce to be credited without trial, I have often herewith relieved convulſive, hypochondriacal, and hyſterical diſorders: and as for actual corruptions of the juices, gangrenes, and mortifications, it is ſo ſerviceable in theſe caſes, as not to have its equal: and this I openly declare upon experience. In ſhort, we ſee that when the violent heat of autumn has already begun a putrefaction in fleſh or blood, they may ſtill be preſerved pure and uncorrupt, by waſhing them with a large quantity of vinegar. I alſo attribute an attenuating virtue to this liquor, contrary to what is done by ſome others; for if mixed warm with the blood, or its ſerum, it does not coagulate but dilute them, without producing any thing grumous, but gently reſolving coagulations. And hence it proves ſo beneficial in burning fevers, the plague, ſmall-pox, meaſles, and the like, where, upon diſſection, coagulations have been ſo often found: vinegar, likewiſe, is the principal remedy, when alcaline, volatile ſalts are in ſuch caſes uſed very unſucceſsfully, becauſe they increaſe the velocity of the blood by their ſtimulating virtue, and conſequently its denſity. The famous *Sylvius*, if not the author, at leaſt a great admirer of the volatile, oily ſalts, depended upon vinegar, as a preſervative from the plague, and ſafely viſited his patients ſick of that diſtemper, after having prepared himſelf by drinking an ounce or two thereof: but having once omitted it, he was preſently ſeized with a pain in his head. I am not acquainted with any more certain ſudorific; for when diluted with water, or drank alone, it ſtrongly promotes ſweat, even in the plague, and the moſt malignant diſtempers, where other remedies will hardly anſwer. (2.) This vinegar ſeems to be generated by a combination of the inflammable ſpirit produced in the firſt fermentation, along with a certain acid, ſomewhat more fixed, that lay concealed in the wine; for that this ſpirit is not here loſt or deſtroyed was ſhewn above. It therefore deſerves to be conſidered, whether that ſpirit be not in the ſecond fermentation united with the tartar, or the eſſential ſalt of the wine. The ſpirit of the wine appears to be here converted into the perfectly altered

altered nature of the vinegar; and if ſo, perhaps, this is one way commonly known, whereby the matter of alcohol is truly changed into another thing. (3.) Perhaps, the eſſential ſalt of the wine, by this means, becomes an admirable tartar; for the tartar is wholly conſumed in making the vinegar, whilſt, at the ſame time, only a viſcous oil is ſeparated from it. For if bright *Rheniſh* wine be put up freſh into a clean caſk, it will produce much excellent tartar; whereas the ſame wine, being converted into vinegar, will afford no tartar, tho' thus kept for a very long time; and yet, as was before obſerved, in this ſecond acetous fermentation there appears to be nothing produced, or depoſited, that any way reſembles tartar, but only the viſcous oily matter we ſpeak of, which is very different from tartar. (4.) In the diſtillation of wine an inflammable ſpirit riſes before the water; but in the diſtillation of old vinegar, the watery part comes over firſt, and afterwards an acid ſpirit, which is always the more acetous, the longer the diſtillation is continued. Whence it appears that the firſt fermentation renders its production volatile, but the ſecond rather fixes its production. The action of fermentation is ſurely wonderful, as it prepares a ſharp wine from a ſweet muſt, and alcohol from a ſubſtance that contained none before; and again, of a ſweet thing generates an acid, and from the matter of alcohol obtains a thing of a very different nature. (6.) The things that promote this acetous fermentation are, 1. A conſiderable warmth; 2. A free admiſſion and even admixture of the air; 3. A motion, and repeated ſhaking or ſtirring together, in the open air; 4. The addition of the keener aromatics in the fermentation.

The things that hinder this fermentation are all thoſe mentioned under the ſame title, in the hiſtory of the firſt fermentation, excepting that conceſſive motion is here ſerviceable, but in the vinous fermentation prejudicial. And thus we finiſh the whole hiſtory of fermentation both vinous and acetous.

PROCESS LI.

The diſtillation of vinegar into an acid water, an acid ſpirit, an extract, a ſapa, a tartar, and an oil.

'DISTILL old vinegar, prepared from the beſt wine, in a tall narrow 'glaſs body, three fourths filled therewith, with a gentle fire, till a 'fourth part is come over, which will be light, limpid, and run along the 'glaſs-head in ſcattered dewy drops like water, not in veins like ſpirit. It 'is of a tartiſh taſte, and quenches fire like water. If this part be again 'diſtilled in a clean body to a half, what firſt comes over will be almoſt 'aqueous, and is of excellent ſervice where very gentle acids are required. 'All the chemiſts have agreed in theſe particulars except one; for *Vigani* 'has wrote that the firſt part which ariſes from vinegar in diſtillation is in'flammable, ſo as to burn in the fire. To reconcile this difference, I ſhall 'here relate, that having received ſome vinegar directly imported from

'*France*,

‘ *France*, before it had acquired a very acid taſte ; and directly putting 20 ‘ pints thereof into a large glaſs retort, I patiently diſtilled with a very mo- ‘ derate warmth, and obſerved, that the riſing vapour ſtreamed down the ‘ receiver in oily veins, as happens in the diſtillation of wine ; ſurprized here- ‘ at, I continued the ſame degree of heat, till dewy vapours began to fol- ‘ low, as happens in the diſtillation of water and vinegar : then examining ‘ what firſt came over, I found it taſte like common ſpirit of wine, diluted ‘ with weak vinegar, and that when thrown into the fire, it flamed like ſpirit ‘ of wine. But having kept the ſame vinegar above a year in a cloſe ſtop- ‘ ped veſſel, and afterwards repeated the operation, the ſucceſs was differ- ‘ ent ; for I procured no inflammable ſpirit, but only an aqueous vapour ‘ of vinegar ; whence I learnt, that the inflammable ſpirit does in time turn ‘ into the acid of vinegar, and that the taſte of vinegar new made is ſome- ‘ what vinous, but that this gradually goes off with age, and the vinegar ‘ becomes more ſharp and acid, whilſt all the former ſpirit is changed, and ‘ only an acid one remains ; and therefore that the inflammable part is truly ‘ converted into vinegar, which is afterwards uninflammable. And hence ‘ we find, that the chemiſts have ſpoke true, and *Vigani* not falſe, if we un- ‘ derſtand him of new made vinegar.

‘ I afterwards diſtilled the vinegar that remained after the firſt fourth was ‘ drawn from it, raiſing the fire a little, and continuing it thus,till two thirds ‘ were drawn off from the remainder ; ſo that of four parts of the old vinegar ‘ at firſt employed, only one remained behind. The liquor appeared in dewy ‘ drops, of a much more acid taſte, and no ungrateful odour, tho’ a little ‘ empyreumatic ; it alſo appeared more ponderous, and, when poured to ‘ the former, ſunk to the bottom thereof : and this liquor we properly call ‘ diſtilled vinegar.

‘ If now the fire be increaſed, and the remaining fourth part be diſtilled ‘ out of a glaſs retort, into a receiver that is not too cold, there will come ‘ over an extremely limpid, and highly acid liquor, ſo penetrating as to ‘ ſweat thro’ the luting ; and it will hardly riſe, unleſs urged by a ſtrong ‘ fire, whence the receiver at that time grows very hot, and eaſily burſts ; ‘ and no veins appear even in this diſtillation, and the liquor obtained will ‘ quench fire. Let the operation be continued, till only a twentieth part, or ‘ leſs, remains of the vinegar employed. The laſt liquor that comes over ‘ ſmells empyreumatical.

‘ A black, groſs, acid, oily, and highly empyreumatical liquor, remains ‘ at the bottom of the retort ; and, if urged with the utmoſt violence of ‘ fire, it affords an exceedingly acid, ponderous, empyreumatical, fetid liquor, ‘ and at length an oil, of an extraordinary burnt ſmell ; leaving a black, ‘ acid fæces behind, which, being burnt in an open fire, affords brown aſhes, ‘ after it has conceived and ſupported a clear flame. Laſtly, there remains ‘ a large quantity of a ſharp alcaline ſalt in the aſhes.

‘ From all this it is plain, that not the leaſt quantity of alcohol remains in ‘ ſo large a proportion of vinegar ; that even the nature of tartar does not here ‘ continue, but that the whole is rather become volatile, except ſome ſmall part ; ‘ and laſtly, that vinegar is entirely different from any other known acid.

‘ We

'We have gone thro' theſe operations to ſhew the nature, compoſition, 'and reſolution of vinegar; but it would be too tedious and coſtly to diſtil 'vinegar in this manner for common uſe. When therefore a quantity of it 'is required, the uſual method is to fill three fourths of a ſtill, tinned on 'the inſide, with vinegar, then apply a glaſs-head, and ſo to diſtil by the 'worm, with a fire ſufficient to make the vinegar boil, and firſt to ſave apart 'the firſt fourth that comes over, then again two fourths, under the name 'of diſtilled vinegar; the fourth remaining in the ſtill may be kept till a 'large quantity of it is acquired, to be diſtilled together for preparing the 'ſtrongeſt kind of diſtilled vinegar for ſome particular operations; but I 'have always found it tainted by diſſolving the copper of the ſtill, which 'unfits it for internal uſe.'

The uſe.

This diſtilled vinegar is an oily ſaline acid, retaining the virtues explained of vinegar in the preceding proceſs, tho' thus rendered more penetrating, active, and volatile, as it is freed from the moſt ſluggiſh terreſtrial part. The ſapa of this vinegar, remaining after the diſtillation in glaſs, when ſeven eighths have been drawn from it, is a very noble preſervative medicine both for internal and external uſe; but by reaſon of its highly auſtere taſte, it requires to be largely mixed with ſugar, or honey, to mitigate it; as *Angelus Sala* has obſerved: this ſapa is a true detergent acid ſoap, which is always the more efficacious the thicker it becomes, as being thus the more oily. We alſo learn by this experiment how ſtrangely the different principles of things may lye concealed among one another; for who could have believed that ſo much oily matter remained in fined-down wine, as is thence ſeparated in the making of vinegar? Who, in ſo hungry a liquor as vinegar, could have expected a black, oily, and thick ſapa? Or laſtly, in a liquor ſo clear, and ſo like water, as diſtilled vinegar, have ſuſpected a copious oil to be lodged? Some eminent artiſts have alſo obſerved, that the acid of diſtilled vinegar, when united with the calx of lead, ſo as to form the ſubſtance called *ſaccharum ſaturni*, concretes therewith into a fat and tenacious kind of ſweet ſugar, which, when gently dried and diſtilled in a glaſs retort, affords a fat liquor, that burns like ſpirit of wine; ſo that this ſulphureous matter lay concealed in the aqueous vinegar, ſo as again to manifeſt itſelf, or be regenerated in the operation: unleſs any one had rather ſuppoſe, that the combuſtible oil was ſeparated from the metallic body of the lead, by the ſoft acid of the vinegar; and that all this combuſtible fluid was only of a metallic origin: which to me does not ſeem probable. For the acid ſpirit of nitre produces an auſtere and ſweet vitriol, by diſſolving lead; but this mixture does not, that I know of, afford any ſuch inflammable liquor by diſtillation. And farther, if pure diſtilled vinegar be poured upon highly calcined ſalt of tartar, an inflammable liquor will be generated, as we ſhall ſhew by a manifeſt experiment in our ſeventy-ſixth proceſs. Nothing ſeems more ſtrange than that the highly acid fæces of vinegar ſhould afford an alcali.

PROCESS

PROCESS LII.

The rectification of distilled vinegar, without addition.

'TAKE any quantity of the diſtilled vinegar of the preceding proceſs, 'and diſtill it to a half, in a tall body, with a gentle fire: let what 'comes over be kept ſeparate, as well as the remainder; the firſt will be 'light, limpid, aqueous, and leſs acid, but the other an exceeding ſharp, 'acid, and more ponderous diſtilled vinegar.'

The uſe.

Wine and vinegar, therefore, are very differently rectified. In wine the firſt, volatile part is the beſt, and in vinegar the remainder. Vinegar, by boiling, is rendered ſtronger and ſharper; but wine, by boiling, ſluggiſh, groſs, thick, unpleaſant and vapid. Hence it is that fleſh, cartilages, bones, and ſkins, by long boiling in vinegar, at length reſolve into a thick liquor, by the force of the acid of the vinegar put in motion, and ſtrengthened by the boiling. And this diſtilled vinegar is perhaps chiefly wanted in all metallic ſolutions, which require a ſtrong acid.

PROCESS LIII.

The rectification of diſtilled vinegar, with verdigreaſe.

'IF plates of the beſt red copper be corroded on their ſurface, by the 'ſpirit that exhales from the huſks of grapes, after preſſing, and lay'ing together to grow warm, a bluiſh, green efflorеſcence is thence pro'duced, which, being ſcraped off, is to be preſerved, and the plates again 'expoſed in the ſame manner, ſo as to produce more of the ſame: and the 'ſeveral parcels, collected together into one maſs, make what is called 'verdigreaſe; which is copper corroded by this ſpirit, and mixed with it. 'It can only be ſucceſsfully prepared in thoſe places where the huſks of 'the grapes have ſo ſharp and penetrating a virtue. This ſpirit, therefore, 'is not the ſpirit of vinegar, but rather of a middle kind, betwixt a crude 'and vinous acid by fermentation. Take of this verdigreaſe, which is 'beautifully tinged of a green colour thro' its whole maſs, put it into a 'clean glaſs-body, and pour rectified diſtilled vinegar thereon, ſo as to 'float three inches above it; ſet them together in a heat of 150 degrees, 'and keep them frequently ſtirring with a ſtick; the ſpirit of vinegar will 'thus be tinged of a beautiful green colour. Decant the clear liquor into 'a clean glaſs, without any of the ſediment, and pour more diſtilled vinegar 'upon the remaining fæces; digeſt, ſtir, let reſt, and pour off as before; 'and repeat this carefully ſo long as the vinegar continues to extract any green-

 'neſs.

'nefs. Let all the coloured liquors be kept together under the title of tinc-'ture of copper; but an incredible quantity is left undiffolved behind.

'Let the tinged liquors be filtred thro' paper, and diftilled, in a clean 'body, with a fire of 200 degrees, till at length the exceeding green liquor, 'remaining behind, collects a fkin on its furface: the liquor that comes over 'will be limpid like water, aqueous, and fomething acid. Let that which 'remains infpiffated behind, be fet to reft in a cellar, where it will foon 'fhoot into elegant, green, tranfparent cryftals, fticking every where to 'the fides of the glafs, like a fmall cruft. Let the unconcreted liquor be 'carefully poured off, that the cryftalline cruft may remain dry, and be 'afterwards farther dried, extremely flowly, in a very warm air, having been 'firft carefully feparated from the glafs; and thus it ought to be kept to 'prevent its growing opake, by too great a heat. Let the remaining liquor 'be again infpiffated to a pellicle, again cryftallized, and feparated as be-'fore; and continue thus till all the true copper, contained in the ver-'digreafe, be converted into pure cryftals of verdigreafe, which are now 'vulgarly called, in the fhops, by the name of diftilled verdigreafe. When 'this is ground to a fine powder, it affords a pigment of a beautiful green 'colour; and if fprinkled upon a foul ulcer, it foon produces an efcar, 'tho' not without pain, and entirely dries up the ulcer, whilft an inflamma-'tion arifing below feparates the cruft: and thus inveterate ulcers are fome-'times excellently healed; for it is corrofive, like the corrofives prepared 'from mercury and filver.

'A proper quantity of thefe cryftals, being diftilled in a glafs retort by 'various degrees of fire, afford at firft an aqueous liquor, which may be 'either kept feparate, or thrown away; but the liquor that next comes 'over acid, unctuous, and running in veins, is to be collected feparate, and 'preferved as a ponderous, and the richeft acid, that can by any art be pre-'pared from vinegar. And hence it is recommended by *Bafil Valentine* for 'the diffolving of pearls; and *Zwelfer* calls it efurine vinegar; and boaft-'ing of it as of the alcaheft, is thence corrected by *Tachenius*. After the 'operation is performed, there remains behind fome powder of the corroded 'copper, that may again be diffolved in diftilled vinegar, and brought into 'cryftals as the former.'

The ufe.

This fermented acid is the ftrongeft that can be procured from vegetables, and therefore richly poffeffes the chemical and medicinal virtues that may be thence expected. And as therefore it raifes the appetite, depraved by a corruption of the bile, or other juices, it is hence called efurine; but proves prejudicial in fuch cafes where lofs of appetite proceeds from an acid in the ftomach, as phyficians know it often does. This alfo lofes its acid virtue, as others do, when mixed with abforbents, and alcalies; fo that *Zwelfer* is not to be credited when he afferts the contrary. The diftilled vinegar confifts of water and acid. This acid is attracted into copper from the vinegar, whilft the water is rejected, and left by itfelf; and the acid

acid adheres almoſt unchanged to the copper, and unites therewith in the form of a ſolid body, but is again driven from it, little changed, by the force of the fire; leaving the copper only reduced to powder, and in other reſpects unaltered. And this can be done by no other body, that I know of, beſides copper; becauſe other metals, as gold, ſilver, mercury, and tin, do not admit this acid; but iron and lead do, tho' they change it at the ſame time; ſo that the acid cannot be obtained from them in a pure acetous form, but is a different thing: and hence it appears how great a difference there is in ſolution. The acid of vinegar is attracted into copper, and reſtored pure from it by diſtillation, without any conſiderable change, but only freed from its aqueous part: lead attracts the ſame acid, and rejects the water; but when endeavoured to be recovered by diſtillation, there is an oily fat liquor obtained in its ſtead, very different from the nature of vinegar: but if the acid liquor of vinegar diſſolves iron, nothing beſides water, here wonderfully changed, is recovered from it. Hence an acid united with other abſorbents, or alcalies, whether fixed or volatile, is never recovered from them, as a pure acid again; ſo that perhaps only copper, or its verdigreaſe, can afford a fit body for ſtrengthening the pure acid of vinegar.

PROCESS LIV.

The generation of tartar from wine.

'WINES, eſpecially thoſe prepared from grapes, or of an acid and 'auſtere taſte, uſually afford a copious tartar, but not in perfection, 'till they are once thoroughly fermented: and they afford the pureſt when 'put up into a clean veſſel. It is more plentifully obtained from the wine, 'when this has reſted ſome time upon the lee, and in ſome meaſure gently 'conſumed it. The tartar of fine white-wine is white, whence *Rheniſh* 'wine affords the beſt, which is white and collected in thick pieces for me-'dicinal uſe; and the whiter, heavier, more ſhining and thick the pieces, 'the better. That of red-wine is red, more impure, leſs firm, and the pieces 'leſs ſolid, and more unctuous: for more of this ſee the eighth proceſs. 'This ſtony ſalt of wine is difficultly diſſolved in water, or wine itſelf, but 'remains almoſt like a ſtone therein. If boiled in a large proportion of 'water, it diſſolves in ſome meaſure, and makes a turbid liquor, wherein 'numerous ſhining corpuſcles are obſerved to float; and thus in the boiling 'it conſtantly throws up a ſkin to the ſurface, which, if taken off with a 'ſkimmer, and put into a wide veſſel to be dried, is called by the name of 'cream of tartar. And thus by degrees the whole quantity of tartar may 'be converted into a kind of white acid powder, excepting only a few fecu-'lent parts, remaining at the bottom.

'If pure white tartar be boiled with twenty times its quantity, or more, of 'water, till the whole is perfectly diſſolved therein, and the boiling liquor 'be now immediately poured into a caſk, without admitting any fæces, a 'cruſt will preſently begin to form on all the internal parts of the veſſel

'touched by the liquor; and this cruſt continually increaſes, till, in a ſhort 'time, nearly all the tartar ſhoots into little ſhining figured lumps, called 'cryſtals of tartar; which, being collected and gently dried, are thus to be 'preſerved ſeparate. The remaining water, when cold, retains but little 'of the tartar.'

Theſe operations ſhew, that the nature of the ſalt which is produced by vinous fermentation, entirely differs in theſe properties from any other known ſalt. A new ſolution alſo of the cream, or cryſtals of tartar, may be made in freſh boiling water, ſo as to obtain them each time more pure and white; but the virtue of them both ſcarce appears greater for any chemical or medicinal uſes, than that of tartar itſelf.

The uſe.

A knowledge of the eighth, and of the preſent proceſs, greatly conduces to the underſtanding of the nature of fermentation, and the tartar produced thereby. And thus we procure this wonderful ſalt ſuited to ſo many uſes. Dyers, ſilver-ſmiths, chemiſts, and phyſicians, require it on many occaſions. The chemiſts prepare many things from it, and ſome of them capital ones. In medicine it is highly ſerviceable for gently cleanſing the firſt paſſages, in a ſmall doſe, or for purging ſtrongly in a larger quantity. And upon this ſubject that candid chemiſt *Angelus Sala* has wrote excellently.

PROCESS LV.

The reſolution of tartar into water, an acid ſpirit, oil, and fixed alcaline ſalt, by diſtillation.

'FILL two thirds of a glaſs retort, with choice pieces of the beſt white 'tartar, and place it in a ſand furnace; apply a large glaſs receiver, 'or one that is of the greateſt ſize, and lute the juncture with a common 'mixture of linſeed meal. Apply a gentle fire for ſome conſiderable time, 'ſcarce exceeding a hundred degrees; there will come over a ſmall quan- 'tity of a limpid, thin, tartiſh, ſomewhat ſpirituous, bitteriſh, and lightly 'odorous liquor, which is ſo penetrating, as eaſily to ſweat thro' the luting. 'Let this be kept ſeparate; then the fire being raiſed to the heat of 'boiling water, a white vapour comes over, and along with it a highly 'penetrating ſpirit, which is wonderfully flatulent, and will paſs thro' almoſt 'any luting; and if we endeavour to confine it by that called the *lutum ſa- 'pientiæ*, it burſts the glaſs by its elaſticity; and it uſually breaks out with 'force, or perſpires at intervals, thro' the luting; and along with this wild 'flatulent ſpirit, there comes over a thin, and extremely ſubtile oil, of a 'yellow colour, a ſomewhat aromatic taſte, bitter, heating, and of no un- 'grateful odour. This ſurprizing oil I have found ſo incredibly penetrat- 'ing, that when the neck of the retort entred five inches into the mouth 'of the receiver, and the juncture was cloſely luted, yet this volatile oil

' always returned back, and paſſed thro' the body of the luting ſo as partly ' to diſtil in drops, into a cup ſet underneath, and in part to run down the ' external ſurface of the receiver: nor could I hitherto by any means pre- ' vent this effect; for if a luting be applied, that the oil cannot paſs thro', ' the veſſel flies to pieces. I did not therefore wonder to find *Paracelſus* ' and *Helmont* ſo highly recommend this oil in diſeaſes of the ligaments, ' membranes, and tendons, which they upon experience have declared may ' be cured by it, even tho' contracted.

' The former matters being collected ſeparate, let the remainder be urged ' gradually to the utmoſt degree of heat that ſand will give, and thus ' again a ſpirit will come over, and an oil, as before; but at the ſame time ' a groſs, black, fetid, ponderous, glutinous, and bitter oil, leaving the re- ' maining tartar, black, ſharp, and in every reſpect truly alcaline. If this ' maſs be urged with the ſtrongeſt fire of ſuppreſſion, it will ſtill yield a ' very thick, black, and pitchy oil, along with a certain ſmoke: and theſe ' will continue to riſe, how violent ſoever the fire be made, and how long ' ſoever the operation is continued; and there will ſtill remain an extremely ' black, ſharp, alcaline and dry maſs, at the bottom; which being expoſed ' to the open air by breaking the glaſs, grows hot upon contact therewith, ' and readily diſſolves into a liquor: nor can it be kept dry, without great ' caution; whereas the tartar, from whence it was produced, would ſcarce ' diſſolve in water.

' When this black dry maſs is expoſed to a naked fire, in the open air, ' it takes flame, and after burning, leaves a copious white alcaline ſalt be- ' hind, as ſtrong, fiery, and pure, as can any way be prepared. It affords ' but little earth, and readily diſſolves of itſelf; if long detained in a ſtrong ' fire, it grows blue, of a marble colour, and ſometimes brown; and thus ' always becomes ſtronger, as we before obſerved in the twelfth proceſs.'

The uſe.

From hence we learn many particulars; and firſt, how wonderful a thing fermentation is, which ſeparates all the groſs parts, and leaves a tranſparent, ſubtile, fluid wine, which generates an almoſt ſtony body, that does not diſſolve in cold water, whilſt the principles of this body lay concealed in ſo thin a liquor. This ſtony maſs alſo contains water, a ſpirit, and different kinds of oil, thick and copious. It is hard to conceive how this oil could lye concealed in the wine, which ſeems to contain alcohol indeed, but no ſuch oil: but what is more ſurprizing, the entire maſs of tartar is merely acid, and makes an effervecence with alcalies, as we ſhall clearly ſee in the ſeventy-fifth proceſs; and yet by the bare action of no violent fire, in a cloſe veſſel, without any conſiderable ſeparation of an acid, the greateſt part of its whole bulk is changed from acid to true alcali: and this perhaps is the only example where a fixed alcaline ſalt is produced in a cloſe veſſel, by a moderate fire, without the free admiſſion of the air; whilſt in other caſes, only a black inſipid coal is thus produced. Who would have ſuſpected that a manifeſt acid could, by this means, have changed to an alcali? And

And if the acid water, the ſpirit, and the oil, be poured back upon this alcaline maſs, from whence they were before extracted, and the diſtillation be performed as before, ſcarce any acid will come over, and little oil, but nearly the whole maſs will be turned into alcali: whence we ſee that a large quantity of a very acid matter may be eaſily changed to an alcaline ſubſtance; but on the contrary, I am acquainted with no inſtance in chemiſtry, of ſuch a manifeſt change of a ſtrong alcali into an acid: whence I cannot ſufficiently admire the particular nature of this tartar, as knowing nothing like it. The firſt diſtilled and highly penetrating oil of tartar is recommended for diſcuſſing cold tumours, and for reſtoring motion to the dried tendinous parts in contracted limbs, together with the aſſiſtance of proper baths, fomentations and frictions. If theſe oils be rectified, and rendered more ſubtile and penetrating, they are recommended by chemiſts, even for reſolving gouty knots and concretions. It is ſaid by many, that rich perfumes may be exalted by this oil; but they alſo ſay, that decayed muſk and civet may have their ſcent invigorated, by being ſuſpended in a jakes. Salt of tartar may be thus prepared in a greater proportion to the tartar employed, than by any other known method; and in greater plenty, the ſlower the diſtillation was performed. This alſo is the beſt, ſharpeſt, moſt penetrating, and pure of all the fixed alcalies; nor is there any other known body in nature that affords more of ſuch a ſaline alcaline matter, than tartar. And if the black alcaline matter, remaining after the moſt violent diſtillation, be ſet by in the retort ſlightly covered with paper, it wholly reſolves into a liquor, which, being filtered, affords an admirable oil of tartar *per deliquium*, extremely fit for numerous chemical uſes, and particular operations. If the ſame ſalt be firſt ſtrongly calcined in an open fire, it thus alſo reſolves in the air, and affords an oil of tartar *per deliquium*, but of a more ſharp and alcaline nature than the former.

PROCESS LVI.

The tincture of gum-lac, by means of the twelfth, forty-ſeventh, forty-eighth, forty-ninth, and fifty-fifth proceſſes.

THE chemiſts obſerve, that certain vegetables diſſolve with difficulty in alcohol; yet being diſſolved therein, ſometimes afforded great medicinal virtues. Such medicines are dragon's-blood, gum-juniper, gum-lac, myrrh, *&c.* which are found of a very tenacious hardneſs, that will not eaſily admit a diſſolution of their parts; which has therefore been attempted various ways, the moſt commodious whereof is the following.

'Gum-lac is brought to us from *Aſia*, and is a kind of roſin ſcraped up
'from trees by the ants, which build their neſts of it, and thus collect it
'in great quantities in the iſland *Ceylon*, from whence the beſt is brought.
'Take of this pure gum, reduce it to fine powder, and moiſten it with the
'alcaline oil of the twelfth, or fifty-fifth proceſs, ſo as to make it into a
'ſoft paſte, which being put into a round urinal glaſs, is to be ſet in our

'little wooden furnace, with that degree of heat, as may gradually dry the 'mafs. Then take out the urinal, and leave it in the open air without fire, 'where the alcaline oil will again refolve; after which it is to be dried a 'fecond time in the furnace, and thus by repeating the liquefaction, and the 'drying alternately, the glaffy tenacity of the gum will be broke, and re-'folved into a liquor of an elegant purple colour. Now let it again be 'gently dried, and carefully taken out of the glafs, as being thus prepared 'for affording a tincture with alcohol.

'Put the matter into a tall chemical glafs, and pour upon it pure alco-'hol, enough to float three or four inches above it; ftop the glafs with 'paper, and fet it in the fame furnace, that it may fimmer for two or 'three hours, which may be done without danger of lofing the alcohol, and 'reafon of the long and flender neck of the glafs. Let the liquor cool, and 'pour off the clear tincture, by a gentle inclination of the veffel, into ano-'ther glafs, that is to be kept well-ftopped. The remainder may be treat-'ed in the fame manner with more alcohol, and the tincture poured to the 'former, till the matter by boiling will no longer tinge the alcohol; after 'which the matter may be thrown away as exhaufted. The feveral tinc-'tures being put together, and purified from their fæces, by ftanding, are 'to be diftilled by a very gentle fire, in a glafs body, till one half of the 'alcohol is come over, whereby being thickened, the remainder is to be 'kept for ufe, under the title of *Tincture of gum-lac.*'

The ufe.

Hence we fee that alcali, with the air and a digefting heat, opens a denfe body, fo as to make it give out its virtue to alcohol; and the reciprocation of drying by the fire, and moiftening by the air, penetrates to the uttermoft parts, tho' there always remain fome fixed part in thefe fubftances, incapable of being diffolved by the repetition of this action: whence the menftruum extracts the more active virtue of fuch fubftances, leaving the groffer lefs active matters behind. And hence we have an effectual, expeditious, commodious, and almoft an univerfal method of preparing excellent tinctures; the general virtues whereof depend upon the prefiding fpirit, fecretly lodged in thefe fubftances, and that often wonderfully contains their peculiar virtues; again upon a rich balfamic part prefiding in the fame; and laftly, upon a corroborating refinous part, which they generally hold; and thefe are added to the virtue of the menftruum, or alcohol before examined. Hence in general, all thefe tinctures may be pronounced heating and exciting to the nerves and fpirits, drying, prefervative, ftrengthening, and conftringent to the veffels: but the prefent particular tincture of gum-lac is of great virtue in curing the diforders of the gums, mouth, and teeth; in the fcurvy, being frequently ufed by rubbing it on the parts; and taken externally, it has the fame virtue, and fafely cures that diforder, if not attended with too much heat. It is alfo of great ufe in the gout, the rheumatifm, and fcurvy, from a fluggifh caufe, as alfo in a *leucophlegmatia*, dropfy, or the like. It may be taken

taken thrice a day in *Spaniſh* or *Canary* wine, after the ſtomach has been firſt cleanſed and emptied. It has a grateful odour and bitterneſs, with an agreeable aſtringency, that ſhews its ſtrengthening virtue, and is therefore highly commended in the cure of the *fluor albus*.

PROCESS LVII.

The tincture of myrrh, by means of the twelfth, forty-ſeventh, forty-eighth, forty-ninth, and fifty-fifth proceſſes.

'PROCEED here in every reſpect as in the preceding proceſs; by 'which means an extremely rich and uſeful tincture will be obtained 'for many purpoſes. This tincture has long been ſought after by artiſts, 'who always complained, that this noble gum could not be held diſſolved; 'and therefore attempted to diſſolve it various ways, by different men-'ſtruums: but by the preſent method it ſucceeds excellently.'

The uſe.

We have here an example of chemical ſolution, chiefly for medicinal uſe. *Helmont* imagined, that if myrrh could find entrance into the innermoſt receſſes of the body, it would have a great efficacy in the prolonging of life, ſo far as this might be expected from an uncorrupted ſtate of the vital balſam. This tincture, by its detergent, embalming, or balſamic virtue, excellently heals any foul ulcers of the mouth, noſtrils, gums, or other parts of the body, by their being touched or rubbed therewith. If the bodies of dead creatures be penetrated with this liquor, they having been firſt warmed, and then dried, it preſerves them uncorrupted. Given internally, it is an admirable remedy in all languid caſes, proceeding from a ſimple inactivity. It is principally ſerviceable in thoſe female diſorders which proceed from an aqueous, mucous, ſluggiſh indiſpoſition of the humours, and a relaxation of the ſolids; and therefore has extraordinary effects in the *fluor albus*, and all the diſeaſes ariſing from the ſame cauſe.

PROCESS LVIII.

The tincture of amber by means of the twelfth, forty-ſeventh, forty-eighth, forty-ninth, and fifty-fifth proceſſes.

'REDUCE the beſt tranſparent yellow amber to fine powder, in order 'to increaſe its ſurface; grind this powder in a glaſs mortar, with 'the alcaline oil made *per deliquium*, according to the twelfth and fifty-fifth 'proceſſes; the longer the better, that it may become a thin, well-wrought 'paſte; put it into an urinal glaſs, dry it in a warm furnace, and reſolve it 'in the open air for ſeveral times, as in the two preceding proceſſes; for it is

'hard

'hard to be penetrated. At length the matter being well dried, put it into 'a tall bolt-head, with a very long and ſlender neck, pour pure alcohol thereon to the height of three inches above it, ſhake them together, and ſimmer them on the furnace for ſome hours, as may thus be commodiouſly 'done. The tincture will become red, and when cool, and grown clear 'by ſtanding, ſhould be carefully decanted from its fæces into a clean glaſs, 'kept cloſe ſtopped. In other reſpects proceed as before, till almoſt the 'whole body of the amber be taken up in the tincture. This may alſo be 'prepared in the ſame manner by the means of alcohol alone, without 'alcali, tho' to better advantage with it.

The uſe.

Hence we ſee, that alcali has a power of gaining entrance for alcohol, into a body brittle like glaſs, whoſe wonderful, reſinous, and particular nature no one has hitherto particularly explained; but in the compoſition thereof, a foſſil acid, and a rock oil, or ſomething like them, ſeem to concur; whence it is difficult to diſſolve. Its tincture, however, is neither acid, alcaline, nor oily, but holds the whole ſubſtance of the amber diſſolved. It is of a bitteriſh aromatic taſte, wonderfully refreſhing, having a perfectly reſtorative fragrance, and ſome degree of ſtipticity. When well made, it in the winter time grows thick, and depoſites a kind of mealy, or ſomewhat reſinous ſubſtance; which ſhews how richly impregnated it was with the diſſolved amber: but when warm weather returns, it again grows clear, and takes up the powder it had let fall. If one half of the alcohol be drawn off from this tincture, the remaining thick part depoſites a kind of powdered amber, which, being collected ſeparate, is of a highly aromatic taſte, and odour. It is very ſurprizing, that this ſubſtance ſhould be ſo equally, and almoſt totally diſſolved in alcohol, without any obſervable ſeparation of its principles; yet at the ſame time acquire ſuch noble medicinal virtues as were not before found in the entire amber; eſpecially, as by diſtillation it is divided into ſuch different parts, each of them of a different virtue and nature, as we ſhall ſee in the eighty-ſixth proceſs.

And hence again we ſee, by a manifeſt example, that chemical productions may differ incredibly, as they are obtained or prepared with a different menſtruum, or in a different manner. And hence alſo we ſee how very different principles may lye concealed in a certain compound, without giving any ſign of their being there, or of manifeſting their own nature; and this, tho' the compound be very ſubtilly divided, either by trituration, or a menſtruum. And hence again it appears, how much a ſimple diviſion, made by a menſtruum, without any extraction of the principles, may produce new virtues.

This tincture has an incredible efficacy in all thoſe diſtempers, which proceed from too great a mobility of the immediate inſtrument of the human affections, ſpirits and nervous ſyſtem; and particularly from a relaxation of the parts, thro' weakneſs. And hence it proves of wonderful ſervice in hypochondriacal, hyſterical, languid, cold, watery caſes, and convulſions often proceeding from them. So that Mr. *Boyle* and *Helmont* have for this reaſon placed it among the nobleſt anti-ſpaſmodics and anti-epileptics, when the diſ-

 order

order proceeds from thofe caufes. And thefe three examples may fuffice to fhew the true methods of extracting tinctures from the hardeft fubjects. The dofe and manner of ufing the prefent are the fame as above delivered under the fifty-fixth procefs.

PROCESS LIX.

Tincture of benjamin, by the means of the forty-feventh, forty-eighth, and forty-ninth proceffes.

'LET this rofin, which fpontaneoufly flows from its tree in plenty, be 'ground to powder, and boiled in a glafs-veffel with fpirit of wine 'once rectified, without any farther preparation; and thus it refolves into 'a red and fweet-fcented liquor, which being decanted clear, and more 'fpirit poured to the remainder, and boiled therewith, nearly the whole 'body of the benjamin is thus diffolved, except a little fhaggy matter. 'But if the alcohol were perfect, and boiled in this manner with the benja- 'min, the tincture becomes the richer: they are both of them odoriferous, 'and of a warm, bitterifh, and balfamic tafte.'

The ufe.

Hence it appears, that an unctuous rofin may be perfectly and totally diffolved in alcohol, fo as therewith to appear in the form of a confiderably homogeneous and thin liquor; a little whereof being poured to a large proportion of water, the mixture immediately turns white, opake, and milky, thence called virgin's milk; becaufe if the face be wafhed therewith, it becomes rofy, and foft, and covered with a thin fhining fkin, if fuffered to dry fpontaneoufly. This mixture, therefore, is efteemed an innocent cofmetic; and when mixed with wafh-balls renders them of an agreeable odour. This rofin of benjamin, and camphire, are wonderfully volatile, with a fmall degree of heat, and fpontaneoufly diffolve in alcohol without alcali.

PROCESS LX.

Tincture of guaiacum, by means of the forty-feventh, forty-eighth, and forty-ninth proceffes.

'PUT the refufe of frefh, green, and ponderous guaiacum-wood, re- 'duced to fmall chips, or take the bark thereof in powder, and put 'it into a tall chemical glafs; pour thereon rectified fpirit of wine, fo as to 'float four inches above it, without any other addition. Boil them toge- 'ther, in the manner above mentioned, for four hours, often fhaking the 'glafs; the liquor will thus become red, which is to be ftrained, after it is 'clarified by reft, thro' a linen ftrainer, to feparate it from any impurities; 'then pouring frefh fpirit upon the remains, boil them again, and preferve 'the

'the ſeveral tinctures pure. The liquor, thus obtained, will be of a pungent, 'aromatic, acrid, hot taſte, and odour: but if the alcohol employed were 'perfect, the tincture will always be the better.

'If this tincture, prepared with pure alcohol, be diſtilled in a tall body, 'with a gentle fire, till only one fourth part be left behind, this will be a 'very rich tincture, fully impregnated with the virtue of the guaiacum. But 'if the ſpirit employed contained any water, the roſin would begin to fall, 'if the tincture was inſpiſſated ſo high. But when pure alcohol is uſed, the 'tincture will eaſily bear to be thickened, and thus increaſe in virtue, with-'out growing turbid.'

The uſe.

We have here an example of an operation, whereby the oily, reſinous, and balſamic part may be extracted from odorous woods, and preſerved and employed for medicinal purpoſes. The liquor, alſo, thus obtained, afterwards ſerves to afford roſins. The virtues of theſe tinctures depend upon thoſe peculiar to the wood, ſo far as they reſide in the aromatic, balſamic, oily, or reſinous part thereof. And thus theſe tinctures are prepared to excellent purpoſe, from *lignum aloes*, ſnake-wood, *Rhodium*, ſaunders, and the like; by the ſame means, and with the ſame menſtruum. This tincture of guaiacum being externally applied, is a wonderful remedy in malignant venereal ulcers; whether in the ſkin, or fat, mouth, jaws, throat, *&c.*

PROCESS LXI.

Tincture of ſcammony, by means of the forty-ſeventh, forty-eighth, and forty-ninth proceſſes.

'THE milky, unctuous, thick juices, which ſpontaneouſly diſtil in plen-'ty from wounded plants, uſually appear reſinous, when inſpiſſated 'by the heat of the air, or ſun: ſuch juices are particularly thoſe of the 'hawk-weeds, ſow-thiſtles, goats-beard, ſuccory, ſpurge, euphorbium, pop-'py, or the like; and theſe juices, when reduced to a dry form, and ground 'to powder, and boiled once or twice with ſpirit of wine, in the ſame man-'ner as above, diſſolve in great meaſure, leaving only a little earthy fæces 'behind: and this is particularly the caſe of ſcammony.'

The uſe.

The tincture of ſcammony, ſo prepared, purges in a ſmall doſe, or in the quantity of two drachms, if mixed in three or four times its weight of the ſyrup of damaſk roſes. Theſe three laſt proceſſes chiefly ſhew the action of pure ſpirit of wine upon vegetable compounds, according to this ancient chemical rule, that ſpirit diſſolves its like. For alcohol, when perfectly pure, ſcarce extracts any thing more from well dried compounded vegetables, than the inflammable parts, ſpirit, balſam, oil, colophony, roſin and reſinous gum, and what is merely ſaponaceous; leaving a pure dry ſalt and earth

 behind.

behind. If, therefore, the artiſt knows that all the particular virtue required preſides in theſe parts, then the operation muſt be performed with pure alcohol alone, as we directed in guaiacum; but when the virtue required lyes in a mixture of the oily, reſinous, ſaline, and ſaponaceous parts together, it is better to uſe the common rectified ſpirit than alcohol; becauſe that ſpirit acts, by its aqueous part, upon what is ſaline and ſaponaceous, and by its alcohol, upon what is balſamic, oily, and reſinous; ſo that by this means the united virtues may be obtained in the tincture. This is evident in the roots of hellebore, hermodactils, jalap, mechoacan, and turbith; becauſe the tinctures drawn from them with a ſpirit only once rectified, purge much better than thoſe extracted by pure alcohol. For if a reſinous tincture be drawn by alcohol from jalap, it purges leſs; whilſt the remainder being boiled in water, communicates a purging virtue thereto. But if the tincture be extracted with common ſpirit, it proves highly purgative; and the remains contain ſcarce any thing worth the extracting. Hence we learn, that a fixed alcaline ſalt is not required in the making of many tinctures, becauſe it would either deſtroy, or change their particular virtues; and that they are not always to be made with alcohol: but we are firſt to conſider what ſpirit ſhould be uſed. All the tinctures, prepared with pure alcohol, will burn entirely away, almoſt like pure alcohol itſelf; whence it is manifeſt, that this menſtruum extracts only the inflammable part from the compound, and leaves the reſt behind. If, therefore, the virtue of a plant entirely reſides in the ſaline ſaponaceous part, to boil it with water is better than alcohol. The opium diſſolved in water is the beſt, the next is that diſſolved in wine, and the next in ſpirit of wine; but always the worſe, the better the ſpirit.

PROCESS LXII.

A purging potion from the ſixty-firſt, and a ſudorific potion from the ſixtieth proceſs.

'IF two drachms of the tincture of ſcammony, prepared as above, with 'rectified ſpirit of wine, be mixed with thrice its weight of a proper 'purging ſyrup, as that of rhubarb, for example, and this doſe be taken 'upon an empty ſtomach, in a diſtemper, conſtitution, and age, that re'quires ſo ſtrong a purge, it commonly has the deſired operation in purg'ing the bile. If the like tincture, prepared with common ſpirit from jalap, 'be, in the quantity of half an ounce, mixed with an equal weight of the 'ſyrup of buckthorn, a potion will thus be obtained, which, without occa'ſioning much diſorder, plentifully purges water: whence we are furniſhed 'with an excellent hydragogue in thoſe diſtempers that require it. And 'therefore this tincture is kept ready at hand, to be mixed up occaſionally for 'pharmaceutical uſe. But when the tincture of guaiacum, prepared with 'pure alcohol, and inſpiſſated to a half, is mixed with four times of the 'ſyrup of the five opening roots, and taken upon an empty ſtomach in the

'morning,

'morning, lying in bed, it presently distributes itself over the whole body, 'which it thus warms, and promotes a copious sweat; and hence it is com- 'mended in the venereal disease, when seated under the skin.'

The use.

Many virtues of vegetables usually reside in their rosins, which are generally tough, and apt, by their tenacity, to stick to one part of the body, and thus their virtues are either retarded or hindered; but when dissolved in a spirituous, vegetable menstrum, they operate quicker, and in a much less dose: rosins dissolved in spirits are so sharp, that they cannot be drank alone; and if diluted with water to render them potable, they are presently precipitated into a tenacious mass: whence nothing seems more proper than to mix them with a thick syrup, where they cannot be precipitated, but are mitigated by the saccharine part, which by its extraordinary simplicity does not at the same time change, or impair their virtue.

PROCESS LXIII.

Virgin's milk, from the twenty-ninth process.

'THE red tincture of benjamin, prepared according to the fifty-ninth 'process, appears transparent, even when viewed with a microscope; 'but if a single drop of water be added to it, it presently turns white, 'opake, and appears dreggy to the naked eye; and if the whole tincture 'be mixed with ten times its quantity of water, it grows perfectly milky, 'thick, and curdled, and throws out nearly all the benjamin, in the form of 'a fine powder, and precipitates it to the bottom of the vessel; so as that 'little of the former taste and odour remains behind.'

The use.

This experiment shews the nature of rosins with respect to alcohol, and to water, as also the nature of a white precipitation of an oily matter in water; (*a*) the production of a resinous body by an extraction with spirit; and the manifest separation of the same, from the spirit, by water. And this resinous substance, precipitated by water, appears like fine, thin, polished skins, which, if laid on the skin of the body, render it uniform, soft and somewhat shining; whence this tincture is used for the curing of pimples, little ulcers, freckles, and breakings out of the skin.

(*a*) See process 15, 16, 17, 21, 26, 27, 28, 29.

PROCESS LXIV.

Rosins, from the sixtieth and sixty-first processes.

'LET the tinctures prepared with alcohol, from fat resinous vegetables, 'according to the sixtieth and sixty-first processes, be first well clari-'fied by standing, then distilled in a glass-body with a gentle fire, till only 'one fourth remains behind: the alcohol thus drawn off is to be kept for 'the same use again. Then pour the thickened tincture into a low glass, 'with the mouth wide enough to admit the hand; and let this vessel con-'tain twelve times the quantity of fair water, in proportion to the thicken-'ed tincture. The mixture thus will instantly grow thick, white, and soon 'exhibit yellow curds, which, fallen to the bottom, constitute a gross, vis-'cous, unctuous, and somewhat transparent matter; then set the glass in a 'sand surface, and draw off the remaining alcohol by means of a still-head; 'continuing the operation so long as the veins in the head shew any spirit to 'rise, and add this spirit to the former. At the bottom there will remain 'the water, with the above-mentioned matter below it. This matter li-'quifies in hot weather, but grows hard in the cold. The water being 'thrown away, tho' it still retains some odour or taste, tho' but little virtue; 'let the resinous matter collect and unite into a mass at the bottom; it will 'first be flexible, soft, and, when touched, stick incommodiously to the fin-'gers; but when washed for some time in several waters it begins to cool 'and harden, and, when dried, appears a hard, brittle, transparent body, 'that will run with heat, dissolve in oil, and alcohol, but not in water, and 'burn in the fire like oil. This matter is called by the chemists rosin; and 'requires to be kept in a cool dry place, and in a close dry vessel.'

This rosin may be thus prepared from almost any oily, ponderous, dry, and resinous parts of vegetables. Nature often produces the like from vegetables, but no where more perfect than in the camphire-tree, which yields a pure, white, transparent, highly odorous, volatile rosin, tho' hard to grind; and next to this is benjamin, which is also a pure volatile rosin, copiously afforded by the tree. But when pure alcohol acts upon resinous plants, whilst yet green and juicy, the water abounding in these juices mixes with the alcohol, and dilutes it; whence it acts like common rectified spirit, or rectified spirit of wine, in proportion as the plant contained more or less water; and thus its action becomes different.

The use.

This experiment, which is considerably general, shews the nature of rosin, which in the plant seems to be a pure thin oil, according to the observations made under the thirty-fourth and thirty-fifth processes, concerning the origin of inspissated oils. And hence chemists are taught under what various physical forms oils may subsist, in respect of heat and cold; for the rosin, which

which in a certain degree of cold is hard and brittle, ſoon reſolves by heat into a pure fluid oil. Some have ſuppoſed that roſins are generated, whenever any ſtrong acid is mixed with a clear oil; upon obſerving that the ſtrong and fiery ſpirits of nitre and vitriol turn with oils into a pitchy maſs, which, when farther perfected by the fire, becomes a true roſin: and therefore that the ſulphur thus produced is a true roſin of the earth. But there is room to doubt whether the coagulation of the oil proceeds from the acid; becauſe by the natural converſion of balſams into roſins the acid is always more ſeparated from the balſam, the more the balſam, which was firſt liquid, grows thick and hard; and at laſt there is leſs acid found in the roſin, than in the more fluid maſs: and even the roſins which are thus ſaid to be produced by a mixture of acid and oil, yet always differ from thoſe prepared by nature, or by the means of alcohol. Theſe roſins ſoon diſſolve in alcohol, but ſulphur never.

The roſins, thus prepared, manifeſt their oily nature by being totally inflammable, and ſeem to contain their former preſiding ſpirit: for the ſmell, taſte, and particular virtue of the ſubject is always found in the roſin, tho' this is to be underſtood only ſo far as it remained in the oily part of the plant. And hence theſe virtues are long detained, and preſerved for years, in the viſcous ſubſtance of the roſin; whereas they would be otherwiſe ſoon loſt in the plant itſelf. And hence it often happens that the roſins, taken into the body, paſs thro' it undivided, by reaſon of their tenacity, and without having their ſpirits extricated to perform their proper actions; as not meeting with the bile, or other ſaponaceous fluid, to diſſolve and open them: and this is frequently regretted by phyſicians, whilſt they direct theſe roſins in form of pills, which may paſs the body without being diſſolved, and without producing the deſired effect. Theſe roſins alſo generally have a manifeſt, ſharp, cauſtic, inflammatory, violent virtue; ſo that if they ſtick to the tongue, or the jaws, they prove very troubleſome by their acrimony; and this effect they often have upon the ſtomach and inteſtines, and thus they may prove miſchievous, by ſtimulating and inflaming. And thus the roſins of coloquintida, euphorbium, hellebore, jalap, ſcammony, *&c.* ſometimes occaſion violent and dangerous purgings, that cannot eaſily be ſtopped. In order to prevent both theſe ill effects, it has been found proper to grind them in a cold glaſs mortar, for a conſiderable time, with an equal quantity of dry ſugar; ſo as thus to prepare a fine powder, which being afterwards mixed and taken in any ſyrup, never paſſes the ſtomach undiſſolved, nor ſticks in the folds of the inteſtines, but proves an excellent and expeditious kind of purge. So likewiſe, if mixed with a little yolk of egg, this will diſſolve their tenacity, and promote and increaſe their efficacy: and when thus treated, theſe roſins alſo will prove purgative, which are obtained from ſimples not purgative themſelves, as we ſee in the roſin of guaiacum.

Some of the greateſt artiſts have obſerved, that the proper diſtilled aromatic oils, abounding with their own ſpirits, grow reſinous, as often as they are deprived thereof. And this is certainly found in ſome oils; for if pure oil of cinnamon be diſſolved in alcohol, and the alcohol be with a gentle fire drawn over from it by diſtillation, it carries over the ſpirit with it, and

leaves

leaves the oil behind deprived thereof, and resinous. But as the purging virtues of certain plants partly reside in that resinous matter, which alcohol extracts, and partly in another active part of the plant, which dissolves in water, as appears in jalap; the remainder of such a plant, after the pure alcohol has extracted all the rosin, will afford another part by being boiled in water. And if this decoction be strained, inspissated with a gentle fire to an extract, and afterwards exactly mixed along with the rosin dissolved in the yolk of egg, there will thus be obtained an excellent composition, containing almost the whole medicinal virtue in a little compass.

PROCESS LXV.

Essential extracts, shewn in saffron; by means of the forty-seventh process.

NATURE has prepared, in certain particular parts of certain vegetables, a determined kind of body, so different from all others as scarce to be referred to any other known kind; and has at the same time endowed it with virtues, otherwise inimitable. We have an example of this in the chives of saffron, which the principal chemists have esteemed so much, as to call it the philosopher's spice, and to denote it by the initial letters *aroph*, which stand for *aroma philosophorum*. It is incredible how rich this saffron is in colour, taste, odour, and virtue; how small the bulk is that possesses all these rich faculties; and how tender and easily corruptible the thing itself is; and therefore requires a peculiar method of operation.

'Take, therefore, two ounces of the choicest fresh *English* saffron, dried, 'and either cut small or remaining whole; put it into a clean bolt-head with 'a long and slender neck, pour upon it so much of the purest alcohol, con- 'taining no foreign thing, as may float four or six inches above it: then 'stop the glass slightly with a wreath of paper, put it into our wooden little 'furnace supplied with a live coal buried under sifted ashes, that the heat 'may be only a hundred degrees. Leave it thus in digestion for three 'days, the vessel being often shook; let it afterwards rest, for twenty-four 'hours, in a cold quiet place; then carefully strain off all the tinged liquor 'thro' a piece of clean linen, placed in a funnel set in a clean glass; and 'keep it closely stopped. It will be of a bright red colour, the saffron, re- 'maining at the bottom of the glass, will be found paler than before. To 'this pour the like quantity of fresh alcohol, and proceed as before, and 'mix the tincture thus acquired with the former; the saffron will now 'remain paler. If more alcohol be added to it, and the process be repeated, 'a still poorer tincture will be obtained, which ought to be kept separate: 'the saffron will now become pale, but otherwise will have the same appear- 'ance, and bulk, as before. To this if water be added, digested there- 'with, and poured off, it will be of a yellow colour; put on fresh, and 'continue thus till no more tincture can be extracted; and now the chives 'will appear quite white; and, if gently dried, will retain their former figure,

'tho' they appeared much ſhrunk, perfectly inodorous, and inſipid, ſo as 'ſcarce to be diſtinguiſhed from bits of clean thread: whence it is wonder- 'ful, where the ſeat of that ſurprizing matter extracted from it ſhould be, 'which is found to give ſo rich a tincture to ſo large a proportion of alcohol. 'Let the tincture, procured by the two firſt digeſtions, be diſtilled in a glaſs 'body, fitted with its head, and perfectly well-cloſed, with a fire of a hun- 'dred degrees, till about an ounce remains behind, which, when cold, is to 'be poured into a glaſs veſſel, to be kept carefully ſtopped. It will prove 'of an exceeding red colour, a highly fragrant odour, and a bitter, aroma- 'tic, penetrating taſte, and have the conſiſtence of thin oil. Let it be kept 'under the title of the eſſential extract of ſaffron. The ſpirit that came 'over in the diſtillation will be limpid, and colourleſs, but retain the grate- 'ful and aromatic ſmell and taſte of ſaffron. This is to be reſerved for the 'ſame uſe; and thus every time becomes the richer.'

The uſe.

This ſurprizing experiment ſhews us a new ſpecies of matter, which we can neither call oil, ſpirit, gum, roſin, reſinous gum, wax, or balſam; but it is ſomething perfectly ſingular, and of a ſpirituous oily nature. This extract mixes with water, ſpirit, and oil, and has ſuch exhilarating virtues, that being uſed too freely, it occaſions an almoſt perpetual and indecent laughing; but uſed moderately, it becomes properly exhilarating; it tinges the urine red, and is particularly ſaid to deſtroy the petrifying power thereof in the kidneys, and therefore to be an extraordinary remedy againſt the ſtone. It is the true *aroph* of *Paracelſus*. There is no occaſion previouſly to digeſt the ſaffron with bread in the heat of horſe-dung, in order to procure its tincture, which is thus rendered rather worſe than better; for in our preſent preparation, all that is efficacious is brought together without loſs, or impairing its peculiar virtues, or any ſenſible change. And theſe preparations being miſcible with any liquor, and of a very penetrating ſubtile nature, eaſily enter the fineſt veſſels of the body, and, by their extraordinary mobility, diffuſe their virtue thro' the whole, and chiefly excite the animal ſpirits. Laſtly, they have that admirable virtue, which the author of nature has planted in them, and which can never be explained upon any principle, and can only be known in itſelf from its effects.

The like extracts may be obtained from ambergreaſe, muſk, civet, balm of *Gilead*, liquid amber, liquid ſtorax, cloves, mace, nutmeg, angelica, galengal, orrice, and other barks and flowers of a ſubtile fragrance; whence it is plain that theſe ſpirits of particular bodies may be extracted and collected by alcohol; and hence their ſudden action ſeems to proceed, becauſe the moſt ſpirituous alcohol, uniting with theſe active ſpirits, makes a medicine that immediately diffuſes its virtue every way, and carries it thro' the body. And when a ſimilar remedy is prepared from ſeveral ſuch ingredients mixed together, it eaſily appears, that thus an admirable remedy may be compounded, rich in united virtues, according to the intention of the artiſt; ſo that nothing of this kind can be invented more effectual. Theſe extracts are beſt taken in canary, or the like rich unctuous *Spaniſh* wine.

PROCESS LXVI.

Eſſential extracts of camphire, by means of the forty-eighth and forty-ninth proceſſes.

'THE extraordinary nature of this ſubſtance, tho' ſeveral times con-
'ſidered, again requires to be examined by this experiment. Cam-
'phire is obtained from its own tree, in the hotteſt countries, being lodg-
'ed in the wood, particularly in the bark, in its own natural cryſtalline
'form. That is the beſt, and moſt valuable, which comes from *Borneo* and
'*Ceylon*. There is another ſort obtained by diſtilling the wood, bark, and
'the root of the camphire-tree, or the cinnamon-tree of *Ceylon*, which has
'the ſmell of camphire; for theſe parts, being infuſed, digeſted, and diſtilled
'with water, afford a limpid, penetrating oil, rich in the taſte and ſmell of
'camphire; and a certain part of this oil, concreting in the cold, turns to
'camphire, which being ſublimed in a clean veſſel with a gentle fire, is
'thus purified. It is clear like cryſtal, hard to grind, extremely odorous,
'and totally and ſpontaneouſly volatile. It diſſolves perfectly in alcohol,
'and therewith makes a pellucid, and highly odorous liquor. Being diſtilled
'along with alcohol, it either wholly riſes therewith, or becomes volatile
'ſoon after, and comes over in a homogeneous liquor. As ſoon as the
'leaſt drop of this clear liquor is put into water, the whole body of the
'camphire is inſtantly ſeparated therein, and recovered; whence it appears,
'that this particular ſubſtance reſembles roſin, tho' it is volatile; in which
'reſpect it differs from all other roſins. It diſſolves in ſpirit of nitre, ſpi-
'rit of vitriol, and *aqua fortis*, as it does in alcohol; but upon the addition
'of water recovers its own nature and ſubſtance, unchanged: but this is
'not found in any roſin beſides; whence it appears, that there is a great
'difference in thoſe called true vegetable roſins. This liquor alſo may, by
'gentle diſtillation, be thickened at pleaſure, and when ſo thickened, ap-
'pears like an oil.

The uſe.

This operation ſhews the nature of camphire already explained. The ſpirit prepared from it by diſtillation is highly penetrating and volatile; it is drying, preſervative, embalming, good againſt gangrenes, promotes perſpiration, and, with reſpect to the blood and ſerum, proves a ſtyptic: but I judge it is leſs proper, when applied to the naked nerves, becauſe it dries too much.

PROCESS LXVII.

Chemical quinteſſences, by means of the proceſſes from the twenty-third to the thirtieth, as alſo the forty-eighth, and the forty-ninth.

'PUT any diſtilled aromatic, or eſſential oil, into a clean and dry glaſs, 'and pour to it twelve times its quantity of pure alcohol, diſtilled 'from alcali, ſo as to contain not the leaſt water. Shake them together, 'and the oil will diſappear, and intimately mix with the alcohol, ſo as to 'form one ſimple and tranſparent liquor; but no water muſt be contained 'in the oil, otherwiſe the experiment will fail.

'Alcohol, therefore, and eſſential oil are of ſuch a nature as intimately 'to mix and unite together, provided they be both perfectly freed from 'water; for if only the glaſs were moiſt, or the breath interpoſed, it 'would hinder the effect; and, when the ſolution is perfect, and the two 'liquors are thoroughly mixed together, the addition of water turns them 'white and opake, whilſt the water unites with the alcohol, and ſeparates 'the oil.

'If the alcohol, ſaturated with the oil, be carefully diſtilled, in a cloſe 'veſſel, with a gentle fire, and ſeveral times cohobated, the oil will thus 'gradually be made ſo volatile, as in great meaſure to riſe along with the 'alcohol: whence oils are rendered more moveable, and more ſubtile, and 'are exalted to the higheſt degree of penetrability, like that of ſpirit, tho' 'ſtill retaining their native virtues. But if, with a fire of only ninety de-'grees, a mixture of alcohol and theſe oils be diſtilled, the alcohol will riſe 'by itſelf, or only carry with it the preſiding ſpirit from the oil, leaving 'the oily part behind: and, if with great care and caution, the thinner part 'be ſeveral times ſeparated from the thicker, by repeated gentle cohobati-'ons, the alcohol will at length be ſo impregnated with theſe ſpirits, as to 'appear almoſt pure ſpirit itſelf, leaving a groſs exhauſted oil behind.'

The uſe.

The ancient chemiſts conceived that fire, air, water, and earth, contributed to the compoſition of bodies, with the addition of a fifth thing, which, made of the four common elements, enriched the whole, by its own particular and inſeparable virtue, whereon the colour, odour, taſte, and virtue of each body principally depends: and therefore they ſuppoſed, that each particular thing, conſiſting of four eſſences, had a fifth eſſence added to it, which was extremely ſmall in quantity, yet of very powerful efficacy, ſo that, when ſeparated and added to another ſubſtance, it animated the ſpirits thereof: upon which ſubject *Iſaac Hollandus* and *Paracelſus* deſerve to be read. There is ſcarce any known method more proper than the preſent for preparing quinteſſences. Thus if a ſingle drop of quinteſſence, ſo made, with oil of cinnamon, be mixed and drank with a glaſs of *Spaniſh* wine, it

inſtantly gives a grateful briſkneſs to the flagging ſpirits, and therefore proves an admirable remedy in faintings, ſuffocation, and want of ſpirits: nor do we know, that the art of chemiſtry can go farther in obtaining the virtues of vegetables. If a drop of ſuch a mixture of alcohol and oil be let fall into water, it preſently turns milky, which ſhews when oils are adulterated with alcohol: and hence alſo we underſtand the power of alcohol, which principally acts upon the ſpirits and oils of plants, by mixing and fixing them intimately with itſelf; and thus making a compound, which afterwards ſeems to act with an uniform virtue. And tho' theſe oils exiſt under very different forms in vegetables, yet they may ſtill be united with alcohol, provided there be no water in either: and we find that the native ſpirit always adheres to this oily matter, under whatever form it appears. All theſe preparations have a great affinity with fire, for ſuch quinteſſences, being taken, heat the body; and if the quantity be large, ſcorch and burn it; when externally applied, they produce all the effects of a ſharp inflammation, even up to a gangrene itſelf: but enough of this for the preſent.

PROCESS LXVIII.

Dry quinteſſences, by means of the ſixty-fifth, and ſixty-ſeventh proceſſes.

'TAKE alcohol, wherein an aromatic oil is diſſolved, pour it upon 'ten times its weight of dry loaf ſugar, reduced to fine powder; 'grind them together exactly for a long time, in a glaſs-mortar, that they 'may unite; put the mixture into a china veſſel, ſet in a glaſs body, kept 'on all ſides moderately warm, that thus the remaining ſpirit, which moiſtens 'the matter, may gently exhale, and by means of a ſtill-head, be collected 'in the form of a liquid quinteſſence. And thus the ſugar will remain 'dry in the china veſſel, yet impregnated with the quinteſſence. Let 'it now immediately be put up into a glaſs veſſel cloſe ſtopped, and preſerved 'under the title of a dry quinteſſence. By taking a drachm of the 'fineſt wheat flower, five drachms of loaf-ſugar, and grinding them dry 'in a glaſs mortar, then adding a drachm of the liquid quinteſſence, and 'proceeding as before, an elegant dry quinteſſence will be obtained.

'By taking a drachm of the liquid quinteſſence, made according to the 'ſixty-ſeventh proceſs, and half a drachm of the eſſential extract, according 'to the ſixty-fifth, and three drachms of fine ſugar, and as much fine wheat 'flower, and proceeding as before, nearly the ſame kind of preparation 'will be obtained, but more compounded.

'And as any of theſe kinds of oil may be diſſolved in alcohol, and ſo 'brought into an uniform liquor, tho' conſiſting of various ſorts, and thus 'employed to the ſame uſes; it appears that theſe noble compoſitions may 'be made by various mixtures at the diſcretion of the artiſt: and hence 'there are infinite ways of varying theſe forms, each whereof may, for 'excellence, vie with the reſt.'

The use.

Here we ſee to what a length chemiſtry may reach in affording forms of medicines of great efficacy, in little compaſs: for if a ſcruple of our dry quinteſſence be mixed with an ounce of *Spaniſh* wine, we have hence a little draught containing the utmoſt virtue that can be obtained from aromatics. If therefore a prudent phyſician ſhall juſtly know the neceſſity and uſe of ſuch a remedy, he may hence derive it from chemiſtry, for his purpoſe. Theſe preparations have this convenience, that they may long be preſerved perfect for uſe, and may be ſafely and commodiouſly carried in voyages, journeys, and in camps, where furniſhed ſhops are not at hand: and here again we have the bounds of chemical perfection.

PROCESS LXIX.

The ſimple aromatic ſpirit of lavender-flowers.

'TAKE ſix ounces of freſh and ripe lavender-flowers, gathered in a 'warm clear afternoon, and twelve pounds of common ſpirit of wine, 'and diſtil by the rules of art, in the alembic and worm, till the liquor be'gins to come over milky. What ariſes firſt is a limpid ſpirit impregnated 'with the taſte and odour of the plant, and muſt be kept ſeparate. A thick 'white liquor will now begin to follow, a pint whereof is to be collected, 'and kept apart: there will remain behind a browniſh black liquor, together 'with the flowers, but not much of the manifeſt virtue thereof; the firſt 'liquor is called the ſpirit, and the ſecond the water of lavender.

'Take three ounces of the like flowers, and pour the former ſpirit and 'water upon them, and diſtil as before. Keep the pure limpid ſpirit ſepa'rate, under the title of the double ſpirit of lavender; but draw off none 'of the white water for fear of burning. A quart of freſh water may 'however be poured into the ſtill, and then a pint drawn over, which will 'ſerve in other the like diſtillations. In the ſame manner, two ounces of 'recent flowers may be diſtilled with the preceding double ſpirit, and the 'water be afterwards obtained; by which means the ſpirit will be ſo much 'the richer in the native ſpirit of the lavender. Water is here added, leſt 'the flowers, added after the firſt diſtillation, ſhould become dry, and burn, 'whilſt the laſt ſpirit was running off. And by repeating the diſtillation 'with freſh flowers every time, the ſpirit thus becomes excellent. The ſame 'operation may be performed, tho' ſlower, in a glaſs body or retort, with 'little trouble, and without foulneſs; and thus I have often carried theſe 'ſpirits to the higheſt perfection. And this operation is univerſal, for 'obtaining all the ſpirits from odoriferous, aromatical flowers; the prin'cipal whereof are garden cloves, ſaffron, jaſmin, lavender, lilies, marum, 'orange-flowers, roſemary-flowers, *&c.* but a principal ſpirit of this kind 'is that of roſemary, every where celebrated, and too much uſed under the 'name of *Hungary* water.

The uſe.

It is eaſy to perceive that the eſſential oil of the flowers is here raiſed in the diſtillation, as in the twenty-fifth proceſs, and along with this oil the ſpirit of wine riſes almoſt pure, like alcohol, according to the forty-eighth proceſs; and therefore this ſpirit diſſolves the ſpirit of the lavender, and the oil that riſes with it, according to the ſixty-ſeventh proceſs. But after the alcohol is drawn off, and the water begins to follow, then the aſcending oil turns the water milky; whence is eaſily underſtood how theſe ſpirits are procured by art, and exalted at the pleaſure of the artiſt.

And hence we may underſtand the virtue of theſe ſpirits, as approaching very nearly to the liquid quinteſſences of the ſixty-ſeventh proceſs, ſo that we need not here add any thing more about them. The agreement appears plain, becauſe theſe ſpirits, when well prepared, turn milky with water.

PROCESS LXX.

The ſimple aromatic ſpirit, from the dry leaves of mint.

'TAKE the leaves of mint freſh dried, and rubbing them a little 'between the hands, put them into a ſtill, and add thereto twenty 'times their weight of common ſpirit: draw off one half by the worm, and 'keep what comes over under the title of ſpirit of mint. Expreſs all the 'juice from what remains in the ſtill, and take half of the former quantity 'of the leaves of mint, and pour the former ſpirit, and all the expreſſed 'liquor thereon; now again diſtil to a half, and repeat the operation to a 'third time, reſerving what comes over under the title of the treble ſpirit 'of mint.'

And thus theſe ſpirits may be produced from all the like plants. This ſpirit of mint is incomparable in vomitings, unattended with inflammation, and for wind and gripings in the ſtomach and inteſtines, proceeding from an acid, mucous, cold, or watery cauſe; for in theſe caſes, half an ounce gives immediate relief.

PROCESS LXXI.

The ſimple aromatic ſpirit from the green leaves of roſemary.

'THE leaves alſo of the richeſt aromatics, tho' leſs juicy, when freſh, 'will excellently afford the ſame ſpirits. Thus, for example, take 'of roſemary leaves, gathered from the tops of the ſprigs, and therewith 'half fill a glaſs retort; pour ſpirit of wine thereon, till the retort be two 'thirds filled; then diſtil in our little wooden furnace into a large receiver, 'as long as the ſpirit appears to run in veins, which ceaſing, it is time to leave

' off,

'off. Let the water, with the rosemary, remaining at the bottom be kept 'apart; then clean the retort, and put in fresh leaves, pour on the former 'spirit, and the water squeezed out from the former rosemary; distil again, 'and repeat the operation to the third time, by which means an excellent 'spirit will be obtained. I formerly in this manner repeated the operation 'a great number of times, in expectation of at length obtaining an extreme-'ly perfect spirit of rosemary, but was mistaken in my purpose; for after 'so many cohobations, the spirit had a very ungrateful odour, like that of 'wax new gathered.

Hence it appears, that the same spirit resides in the flowers, leaves, and even the tender twigs of certain plants, and may thence be extracted; for this spirit cannot be distinguished from that prepared from the flowers of rosemary in the sixty-ninth process, and has the same virtues. The flowers of lavender, thyme, wild-thyme, sage, origanum, calamint, and all the sharp aromatics, are fit for this operation. And hence also it appears, that the same aromatic spirits may be obtained excellent from the dry barks, woods, roots, and seeds, as well as the green; as we see by the noble spirit, which may thus be drawn from yellow saunders.

PROCESS LXXII.

A compound aromatic spirit.

IT has sufficiently appeared, that the presiding spirit is a particle wherein a particular virtue resides, that has often an incredible power; and that this spirit is lodged in essential oils: again, that these oils may, along with their spirits, be mixed among one another into an uniform fluid, in which all these spirits are united together; and lastly, that this mixture may be dissolved in alcohol, so as to make a liquor extremely rich in medicinal virtues, or a certain compound, aromatic, oily spirit. It easily appears, that there is no one certain limited method for preparing these spirits, provided only such simples are chose, as agree in smell and taste, whose virtues will answer the trouble of the composition. The following process therefore will serve as an example, rather than a rule; being what I have often used for the making of a *sal volatile oleosum*.

'Take of fresh *Sevil* orange-peel, cinnamon, citron-peel, *China* orange-'peel, and lemon, of each four ounces; the flowers of orange, citron, le-'mon, lavender, red roses, and rosemary, of each two ounces; the roots of 'angelica and florentine orrice, each an ounce; cloves, mace, and nutmeg, 'each two drachms; rectified spirit of wine fifteen pounds; distil accord-'ing to art, in a common alembic, so long as the spirit comes over limpid, 'and let this be kept separate, as likewise the next two or three pints of 'white liquor, under the title of aromatic, spirituous compound-water. 'When the operation is intended to be repeated, take all the above-men-'tioned simples, and the spirit of wine as before, and add to them all the 'water here prepared; by which means, the spirit obtained will be the more

'more excellent: and thus procuring and reserving the same water each 'time, and using it seasonably, I have always obtained noble spirits, as may 'be easily imagined; for at length they were pure like oil. When the 'spirit, thus prepared, is again to be drawn over from a few of the same fresh 'simples in a glass body, suspend in the still-head a little ambergrease, 'first well ground, and included in a piece of linen; and thus the ascend- 'ing spirit will subtilly dissolve its fragrant part, and mix therewith.

The use.

By considering what is delivered under the sixty-ninth, seventieth, and seventy-first process, it will easily appear to what purpose these spirits may serve, and how far their virtue may properly reach; for they can never, by any known art, be converted into the spirits of the body, but always remain of their own foreign nature, whatever chemists may say to the contrary: and therefore they can never supply the defect of animal spirits. Consequently, it is impossible that the admission of these into a body worn out with age, should supply the office of the vital spirits; they however, by their wonderful agility, grateful fragrance, agreeable taste, and a certain inexplicable affinity with the animal spirits, wonderfully contribute to excite them of a sudden, but for no long time, and by their too powerful actions they will oppress and destroy the native virtues of our spirits. And hence, when internally used, tho' they raise the spirits for the present, they commonly leave the body much more languid, and always in a state that requires to be further stimulated by the same means. And thus I conceive that I have sufficiently explained their true uses, according to the rules of genuine chemistry and medicine.

PROCESS LXXIII.

Soap from express'd oils and fixed alcali, by means of the thirteenth process.

'TAKE a quantity of express'd oil-olive in one glass, and an equal 'weight of oil of tartar in another, pour the oil gently upon the lixi- 'vium, and it will float thereon, and the two liquors remain perfectly di- 'stinct. Shake the vessel wherein they are both contained, and the mixture 'will immediately appear white, opake, thick, and somewhat viscous; and, 'when suffered to stand in this state, it will continue for some time equally 'mixed, but at length the oil and the lixivium will separate from each other; 'whence it appears, that express'd oils, by means of the acid always lodged 'therein, are disposed to mix with alcalies, even tho' diluted with water; 'but that this union is so weak, as easily to be separated. Again, it 'seems probable, that the acid is the means of procuring this combina- 'tion; because oils, deprived of their acid, more difficultly unite with alca- 'lies. If this mixture be gently boiled over a slow fire, till the water is gra- 'dually exhaled, it comes into one consistent white mass, of a nauseous oily 'smell, and a sharp, alcaline, ungrateful, unctuous taste; and will easily re- 'solve in the air: but if in the boiling, a just proportion of the dissolved al- 'cali or oil be added, or mixed therewith, so as that the compound may

'perfectly

'perfectly diſſolve in water, without ſeparating from its oil, and yet maniſeſt nothing alcaline to the taſte, and remain long in the air without running, it is then called perfect ſoap. It was afterwards found, by a ſucceſſive repetition of experiments, that the ſtronger the alcali, the more perfect the ſoap; and as it was obſerved, according to our thirteenth proceſs, that quicklime wonderfully increaſes the power and fiery nature of alcali; an alcali, prepared by means of the ſame, began to be uſed inſtead of the ſimple kind, for the making of ſoap; and becauſe they alſo obſerved, that the union was made more perfect by long continued boiling, and that this boiling required a larger proportion of water, they added water more plentifully, and at length, by repeated trial, they likewiſe found that a certain proportion of oil and alcali was required; and thus by ſucceſſive degrees, the certain and determinate way of making ſoap was found.

'They take the fixed, alcaline, fiery ſalt, prepared with quicklime, according to the thirteenth proceſs; this they diſſolve in ſuch a proportion of hot water, that the lie may ſupport a new-laid egg; and this the ſoap-makers call their capital lie. They afterwards dilute a part of it with more water, till a freſh egg will ſink therein; and this they call their weaker lie. They afterwards mix their oil-olive with an equal weight of this weaker lie, by ſtirring them well together, till the whole becomes white, then boil the mixture with a gentle fire, keeping it continually ſtirring, till the water being exhaled, the remainder begins to unite; at which time they throw in thrice the weight of capital lie, in proportion to the oil, and mix and boil till the maſs becomes ſo thick, that a little of it, laid upon a cold ſtone, appears to be of a due ſolid conſiſtence; and if now a part of this cold maſs is diſſolved in water, it manifeſts no ſigns of oil. This ſhews that the oil is well united with the alcali; but if any oil ſtill appears, the addition of a little more capital lie is required; and the boiling muſt then uniformly be continued till the ſoap will perfectly diſſolve in water: at this time the ſoap is taſted, and if it proves ſharp and alcaline, it is a ſign that alcali abounds too much therein. And therefore a little more oil is added, and the boiling continued, till at length a maſs is obtained, ſo hard as to cut in the cold, and that will perfectly diſſolve in water, and neither taſte alcaline upon the tongue, nor run ſpontaneouſly in the air; and thus the ſoap is perfected.

'Inſtead of oil-olive, any other fat ſubſtance may be uſed, as the fats of animals, and the oils of fiſh; thus black ſoap is made from train-oil, or the boiled blubber of whales: but the purer the alcali is, and the more ſcentleſs, taſteleſs, and leſs ungrateful the oil, the better the ſoap, eſpecially for medicinal uſe.

The uſe.

Here we ſee an intimate combination of native oil with fixed alcali, by means of water and fire, into a homogeneous maſs, which will perfectly diſſolve in water; whence it appears, that the oil here loſes its former fat nature, and acquires another more agreeable to water; and that this is brought about by the means of ſharp, fixed alcali. And therefore where the hu-

mours of the body abound with oil, ſalts are generally uſeful; and conſequently in this caſe a prudent uſe of fixed alcaline ſalt may be allowed. And hence alſo we are ſhewn a way, whereby the acrimony of alcali may be entirely blunted, ſo as to grow ſoft, and put off its corroſive nature, *viz.* by the means of oils. Whence again, in ſuch caſes where the like ſharp, ſaline matter predominates, freſh expreſs'd oils, drank in plenty, will blunt it; and this has been often practiſed with good ſucceſs in the acuteſt diſeaſes, and the more pernicious kind of ſcurvy; and, again, when this acrimony is ſpontaneouſly generated in a certain place, as in the kidneys or bladder, where the ſtone, drinking in the urine, turns it to this kind of acrimony: but in the ſoap ſo produced, tho' the tenacity of the oil is aboliſhed, yet the former virtue of the lixivial ſalt remains, whereby it deterges, without danger of corroding; for when mixed with water, it makes a ſtrong ſaponaceous lie, which by heat, motion, and trituration, diſſolves gums, oils, roſins, and groſs fats, rendering them alſo ſaponaceous, or ſoluble in water; and thus it has a ſcouring, detergent, opening, cleanſing property. And hence it renders coagulated humours fluid, opens old obſtructions, and thereby reſtores the loſt uſe of the parts. It alſo has great effects upon concretions, conſiſting of groſs earth and oil; it prevents acids from coagulating the chyle or milk, and even reſolves them after coagulation. Whence it appears to be almoſt an univerſal opener, diluter, reſolver, and thinner in the body, in the above-mentioned caſes; being drank upon an empty ſtomach, well diluted, and at different times, in a ſufficiently large quantity, and aſſiſted by the motion of the body. It is likewiſe wonderfully ſerviceable, being externally applied in ſinuous and fiſtulous ulcers. It may be tinged and diſguiſed, by giving it a grateful colour with ſaffron, turmerick, cochineal, or other pigments; and if it ſtill proves diſagreeable, on account of the nauſeous ſmell acquired by the oil in boiling, it may be corrected by a little balſam *Peru*. But its uſe is highly pernicious in thoſe diſtempers where life is in danger from a putrefaction, that diſſolves and corrupts the humours, as has frequently appeared in the plague and other putrid diſtempers, according to the juſt obſervations of *Diemerbroeck*. Many other particulars of chemical and medicinal uſe may be eaſily deduced, concerning this noble production, from what is above delivered. Soap affects what neither water nor oil could perform, does that with ſafety that alcalies do with danger, and can perform what other ſalts cannot.

PROCESS LXXIV.

Soap, from diſtilled oil and fixed alcali; by means of the twelfth proceſs.

CHEMISTS, conſidering the virtues, which by experiment they found in diſtilled oils, were concerned to find, that theſe oils, not mixing with water, could not enter and act upon the humours of the body; and therefore obſerving that expreſs'd oils might be ſucceſsfully united with fixed alcali, they went upon trying the ſame with diſtilled oils, but found that theſe loſt their virtue by boiling, and even could not thus be joined with the alcali; and

hence tried various experiments to unite theſe different bodies, till excited by the directions and promiſes of *Helmont*, ſome of them ſeemed to have found the means of effecting the thing. I my ſelf formerly made many tedious experiments to this purpoſe, and at length ſucceeded, as I ſhall now relate. The ſecret conſiſts in this, that the alcali ſhould be perfectly ſharp, pure, and dry, and come in contact with an oil perfectly deprived of water: all the reſt is ſucceſsfully performed by the atmoſphere; but if the leaſt water ſhould enter, the experiment will be fruſtrated.

'Take the pureſt and ſtrongeſt fixed alcali, prepared according to the 'twelfth proceſs, in the fifth paragraph, and grind it in a clean iron mortar 'with an iron peſtle to fine powder, the finer the better, whilſt it ſtill re- 'mains thorowly hot from the fire, and almoſt ignited; then put it into an 'extremely dry, and well heated urinal, and ſet it in a hot and dry place, 'on a clear and dry day; and at the very inſtant that the hot ſalt is all col- 'lected at the bottom of the glaſs, let fall therein the true ætherial and pure 'oil of turpentine, ſo that one drop may immediately follow another, and fall 'upon the middle of the hot ſalt; the oil itſelf having being firſt well heated; 'and thus the oil will immediately, with a great fume and a hiſſing noiſe, 'be attracted into the thirſty ſalt, and diffuſe itſelf intimately thro' the whole 'maſs. Continue to pour in the oil quick, till enough is entred into the 'ſalt, and floats above it, ſo as to prevent it from touching the external 'air, which is always moiſt with water, or from touching the ſurface of the 'ſalt. Set the glaſs in a cellar, where being covered with paper, the oil 'will ſoon diſappear, and be united with the alcaline ſalt; then pour ſome 'more of the warm oil thereon, and mix it with a ſtick into the former maſs. 'Set the whole by, as before, and continue thus, till nearly thrice the 'quantity of the oil is united with the ſalt; the whole will be now a ſapo- 'naceous and penetrating maſs, which, the more it is ſtirred, the ſooner and 'better it is made; whence it may be expeditiouſly obtained, by putting it 'into a ſtrong glaſs, and ſuffering it to be carried daily, and ſhook in a ſtage 'coach, as Doctor *Grew* and *Bohn* have formerly obſerved. The experi- 'ment has always ſucceeded well, when I have obſerved the foregoing cir- 'cumſtances; but never, if the leaſt of them were neglected. The operation 'is known to be well performed, if a little of the ſoap will mix with water, 'without manifeſting any ſign of oil. If the ſoap, thus prepared, be long 'kept in the urinal, there uſually riſes, by degrees, along the ſides of the 'glaſs, a certain white cryſtalline ſalt, of no diſagreeable odour, and of a 'penetrating, mild, ſaline, but not alcaline taſte; which is wonderfully inſi- 'nuating, eaſily ſoluble, and affords an highly uſeful, medicated ſoap.

And this ſalt, which is but little in quantity, I ſuſpect gave origin to the aſſertion, which perhaps is too free, that fixed ſalt of tartar was here rendered volatile by means of oil added thereto, ſo as to become a ſubſtitute for the alcaheſt; but when I urged this ſoap with fire, after it was well prepared, I did not find the promiſed volatile ſalt.

The uſe.

This experiment alſo ſhews us the thirſty nature of pure fixed alcali,

 whereby

whereby it drinks in, and unites these salts with itself; and again, how a sharp fiery alcali may be softened into a mild oily salt. We have sufficiently spoke to the virtue it has against acid, austere, and viscous coagulations, under the former process; we must however observe that all the virtues there related are here found more noble and active, and constantly somewhat heating. And hence we understand the nature of distilled oils with regard to fixed alcalies, or of fixed alcalies with regard to them; and of the new production by a proper combination of the two. *George Starkey*, and his followers, call this soap volatile; but I could never find it so, as I said above. This is the soap which *Matthew*, an empirick of *London*, made under the title of *Matthew*'s corrector, wherewith he mixed opium, and the roots of hellebore and liquorice, and then digesting them together, he made general pills thereof, that were diaphoretic, scarce emetic, or purgative, but anodyne, tho' they would often vomit the next day. *Starkey* published a more correct preparation of these pills at the end of his *Pyrotechny*, where he boasts of their virtue after the manner of chemists, unjustly pretending that the virtue of the hellebore remained entire, tho' deprived of its vomiting quality. And so much for the making of soap. The excellent Mr. *Homberg* observes that a strong lixivium hereof, mixed with a sharp acid, is strangely muddied and changed; whilst the alcali being attracted by the acid, lets go the oil. These soaps being well dried and digested with pure alcohol, are in some measure resolved into the lesser *elixir of the philosophers*, where the sulphur and spirit are united.

PROCESS LXXV.

The preparation of tartarised tartar.

'REDUCE the purest white tartar to fine powder, and boil a sufficient quantity thereof with ten times its weight of water, in a 'large copper vessel, till the tartar appears sufficiently dissolved; let the 'vessel remain over the fire, that the water and the tartar may continue 'constantly boiling; the liquor, being now tasted, proves acid, and is almost 'transparent, and tolerably pure. Then let fall from an height a quantity 'of oil of tartar, drop by drop, into the boiling liquor, which is still to be 'kept boiling, whilst the oil of tartar is dropped in. Upon the falling of 'each drop, there arises a great ebullition in the liquor, proceeding from 'the meeting of the acid and the alcali, as appears from hence, that the 'ebullition soon after spontaneously ceases, and is raised again by dropping 'in more of the alcaline liquor; and because this is performed in a strong 'boiling heat, large spherical bubbles are generated on the surface of the 'boiling liquor, that presently crack, burst, and appear again. In these 'bubbles chemists have found, or rather imagined they found, the figure of 'grapes. The operation is thus to be patiently continued, till at length no 'more effervescence arises from dropping the alcaline liquor into the boiling 'lixivium. And now the acidity of the tartar will be so saturated with 'such a quantity of its own alcali, as neither to appear acid, nor alcaline,

'but

'but a third new ſalt. But this point of ſaturation muſt be exactly hit, 'otherwiſe the ſalt will be acid if too little alcali were added, or alcaline, 'if too much; great caution muſt therefore be uſed at the end. This li-'quor is to be ſtrained hot and quick thro' flannel, till it becomes clear; it 'will be of a blackiſh brown colour, of a particular bitteriſh, ſaline, unctuous 'taſte, but ſcentleſs; if inſpiſſated by heat, till a ſkin appears on its ſurface, 'and then ſet for ſome time in a cold place, it depoſites to the bottom and 'ſides of the veſſel, certain ſaline grains, which when collected, are a tartar 'eaſily ſoluble in water, even in the cold; whereas before it could ſcarce 'be diſſolved therein, without a boiling heat: whence this preparation may 'properly be called ſoluble tartar.'

The uſe.

Tartar comes ſo near to a ſtony hardneſs, as to remain inſoluble in its own wine, which is thus contained, as it were, in an earthen veſſel; whence the *Germans* appoſitely call it *wine-ſtone.* It has a manifeſt acidity; by the prevailing force thereof it acts kindly upon the firſt paſſages; and this acidity is the cauſe that it makes ſo ſtrong an effervеſcence with its own fixed alcali, which is ſo eaſily produced from it, as we ſaw in the fifty-fifth proceſs. For, after this acidity is overcome by the alcali, the tartar becomes eaſily ſoluble, and a new kind of ſalt, which has a conſiderable virtue in the body, when taken upon an empty ſtomach, diſſolved in water: for thus it deterges, and gently purges, and helps to cure many inveterate diſeaſes. Externally uſed, it cleanſes foul ulcers, and diſpoſes them to heal: but whether this be the boaſted remedy of *Paracelſus*, by means whereof he declares he cured all freſh wounds, in a few hours, without ſuppuration, I cannot tell. That medicine he called *ſamech*, which ſeems derived from the *German* word, which ſignifies to conglutinate. Thus much I can ſay, that a ſolution of this ſalt in water, is one of the beſt menſtruums hitherto known in chemiſtry; as any one may learn by boiling gum-lac, myrrh, and the like therein. Whence he will find it can ſcarce ſufficiently be commended; and hence it is plain, that uſed as a medicine, it will diſſolve viſcous matters in the firſt paſſages; and it is even ſuppoſed to diſſolve the tartarous matter of the human ſtone, generated in the receptacles and paſſages of the bile and urine, provided it be uſed plentifully, every day, the doſe being gradually increaſed. It is uſeful in the ſtone, jaundice, and hypochondriacal diſorders. Laſtly, the examination of this proceſs ſhews, how proper cream of tartar is in all thoſe diſtempers, where the bile in particular, and other humours putrefy in the inteſtines, from a burning fever, or other cauſes, and thus become alcaline; for this diſpoſition is then corrected by the latent acidity of the tartar, and at the ſame time converted, in the body, into a mild aperitive and ſoluble ſalt, which opens the paſſages without greatly ſtimulating them, and clears away obſtructions.

PROCESS LXXVI.

Regenerated tartar.

'TO a quantity of ſharp, pure, and dried fixed alcali, contained in a 'large glaſs, with a narrow neck, pour ſtrong diſtilled vinegar, till 'it almoſt covers the ſalt; ſcarce any ſenſible effervеſcence will appear, 'which ſeems ſtrange, becauſe ſo ſtrong an alcali might be expected to 'make an effervеſcence with the acid; but it ſeems, on the other hand, as 'if ſo weak an acid would not make an ebullition with ſo ſtrong an alcali: 'ſhake them ſtrongly together, and then ſome ſmall, ſhort-lived ebullition 'appears. Pour on more diſtilled vinegar, and then a greater ebullition will 'ariſe, and appear ſufficiently manifeſt; after ſhaking the glaſs, add a third 'quantity, and then a violent ebullition, frothing, and hiſſing, will be found, 'and prove the ſtronger, the more the glaſs was ſhook; and this continues 'a long while, ſo that the vinegar poured on makes the ſtronger effer'veſcence, the nearer the operation approaches to the point of ſaturation 'with the alcali; which point is generally obtained, when about fourteen 'times the weight of ſtrong diſtilled vinegar is added to the alcali. Now, 'towards the end, let the mixture be well heated, and long and ſtrongly 'ſtirred, that no more acid may be poured on, than is exactly required to 'obtain the point of ſaturation; which will at length be hit, by continuing 'to add a little of the diſtilled vinegar by degrees, and well agitating the 'mixture, till the addition, and ſhaking in of a little more, no longer cauſes 'an effervеſcence, even in the heat. Then let the mixture ſtand warm, 'for twenty-four hours; and if upon ſhaking, it makes no ebullition, again 'drop in a little vinegar, and ſhake the veſſel, and if now no effervеſcence 'ariſes, then the exact point of ſaturation is hit. During the experiment, 'the violent effervеſcence throws off a very elaſtic vapour, which burſts 'out of the glaſs with a hiſſing noiſe, after having been confined by preſ'ſing the hand againſt the mouth of the glaſs, whilſt it was ſhook, and then 'ſuddenly taking it away: and if the orifice ſhould be cloſely and ſtrongly 'ſhut up, during the effervеſcence, the glaſs would be burſt to pieces. The 'liquor, thus prepared, is tranſparent, of a particular odour, not acid, and 'of a taſte neither acid nor alcaline, but particularly ſaline, and almoſt with'out acrimony. It has a mild and innocent virtue, tho' powerfully attenu'ating and reſolving; being purgative, diuretic, and ſudorific; whence it 'proves an admirable remedy in chronical diſeaſes, attended with a tenaci'ous matter, being given in a proper doſe, at proper ſeaſons.

'The liquor being decanted clear from its fæces, and diſtilled in a glaſs 'alembic, affords a pure ſimple water; whilſt the liquor remaining behind 'becomes of a brown or blackiſh colour, and at length perfectly black, 'fat, thick, of an extremely penetrating, or as it were melting taſte, which 'diſcovers it to be of a ſaponaceous, penetrating, and reſolving virtue. 'Take a little of this liquor, and mix it with a little vinegar; when if it 'yields an effervеſcence, this ſhews that the alcali ſtill predominates, and

'therefore

'therefore the whole muſt be again ſaturated by the careful addition of diſtilled vinegar; and as this uſually happens to be the caſe, the point of ſaturation is to be carefully and anxiouſly ſecured.

'When at length this is happily obtained, let the liquor be ſeparated by reſt from its fæces, and then all the water be drawn off by a gentle fire, till a ſaline maſs remains at the bottom, of a black, reddiſh colour, and a highly penetrating, but very particular ſaponaceous taſte. This maſs will have attracted, and retained all the acid of the vinegar, and given out all the water. Mr. *Homberg* has laboriouſly ſhewn, that the weight of the fixed alcali is here increaſed nine twentieths, in reſpect of the alcali, by the acid of the vinegar ſo attracted; and that this acid, in reſpect of the vinegar, was in the vinegar about a thirty-ſeventh part of the whole; the other thirty-ſix parts being pure water (*b*). And thus the ſalt is procured, which the chemiſts call regenerated tartar.

'If the ſalt, thus laboriouſly prepared, be urged with a ſtrong fire, it becomes volatile, and flies off into the air. When carefully dried with a very gentle fire, it appears like a maſs that had ſtrangely concreted in the cold, by the appoſition of little thin plates, like *talc*. It preſently runs with heat into a kind of thick oil, but again appears leafy in the cold; and hence it has been called *terra foliata*: and *Tachenius* pretending it to be diſſolved talc, is taken to taſk for it by *Zwelfer*, in his apologetic diſcourſe againſt *Tachenius*.'

The uſe.

There is not, in all chemiſtry, a more inſtructing experiment than this; it ſhews us a new, unexpected, and particular appearance of alcali and acid, in the making an effervеſcence. We here ſee all the degrees of colour from the tranſparent whiteneſs of water, up to blackneſs; we ſee that a fat inflammable oil is regenerated from alcali, calcined by a violent fire, and a thin, hungry ſpirit of vinegar; for this dry ſalt takes flame in the fire, and, when diſtilled with a ſtrong heat, affords a true oil. Hence we learn, that ſalts produced by a mixture of acid and alcali, are not barely made up of the acid and alcali as they are again ſeparable, but that a new thing is produced, of which no ſign appeared before. We are taught what proportion of acid, and what proportion of water, is contained in an acid liquor; what proportion of acid is required exactly to ſaturate an alcali; and the true manner of converting fiery, fixed alcali, into a mild compound, volatile, ſaponaceous, oily ſalt. This ſalt, when properly prepared, is a moſt admirable menſtruum, converting its ſubject, by mixture and digeſtion, into a uniform ſoluble maſs, that will readily paſs thro' the body, and remain rich in its own virtues: it is the greateſt reſolvent in the body hitherto known, and therefore highly valuable, as it is not hurtful in hot caſes, yet ſerviceable in cold ones, and almoſt ſuited to every patient. Upon carefully conſidering all theſe particulars, I have often doubted whether this were not *Helmont*'s volatile ſalt of tartar, which he ſo highly commends, and ſubſtitutes for the alcaheſt

(*b*) See *Memoir. de l'Acad. Roy.* vol. I.

itſelf,

itself, especially since it flows like wax at the fire. It seems certainly to be the *acetum radicatum* of the ancient chemists, as in its preparation vinegar returns, and is joined with its own matrix of calcined tartar; but whoever shall over carefully endeavour to dissolve, purify, filter, inspissate, or calcine this salt, in order to make it white, he will find it fly off into the air, and be lost, and may thus indeed be convinced of its volatility, with the loss of his labour and cost. And this admonition I give, chiefly because *Senertus* recommends a scrupulous diligence in purifying this salt; which is not only a lost, but an impoverishing labour.

PROCESS LXXVII.

Tincture of tartarised tartar.

'REDUCE dry tartarised tartar, prepared according to the seventy-'fifth process, to fine powder; put it into a tall bolt-head, and pour 'pure alcohol thereon, till it rises four inches above it. Stop the glass 'with paper, and boil gently in our little wooden furnace for twenty-four 'hours; by which means the alcohol will become of a gold colour, and of 'an aromatic, hot, penetrating taste. If the operation be repeated with fresh 'alcohol, a white salt will remain at the bottom. Let the tinctures be in-'spissated by a gentle fire, till a tenth part remains condensed behind.'

The use.

This process serves to shew that part in the salt which dissolves in alcohol. The tincture thus prepared is aromatic, heating, cleanses ulcers, and heals up wounds: the remaining salt is purer, and more simple than before; which shews, that salts may be whitened, by drawing a tincture from them with alcohol.

PROCESS LXXVIII.

The dissolution of regenerated tartar in alcohol.

'PUT regenerated tartar, prepared as above, and made as dry as it can 'be with safety, into a tall bolt-head; pour thereto six times its quan-'tity of pure alcohol, and boil them carefully with a gentle fire, in our lit-'tle wooden furnace; they will thus be united into an uniform compound 'liquor, that deposites some fæces at the bottom; which being subsided, 'let the liquor be poured off pure. And if any salt remain undissolved be-'hind, add fresh alcohol, and proceed as before. Lastly, distil the liquors 'with a gentle fire to one half; and thus the tincture or solution of rege-'nerated tartar will be obtained.

The use.

We have here the alcali, the oily acid, and the oily spirit of vegetable subjects united together, whereby the most active principles of plants are freed

freed from their indolent earth, and yet remain ſafe, or not dangerous, on account of their acrimony: and this mixture alſo ſeems to be the leſſer elixir of the philoſophers; which the ancient chemiſts commended for reſtoring health. Certainly it diſſolves almoſt all obſtructions, penetrates the veſſels, agreeably ſtimulates the vital faculties, and cures by ſweat. It is alſo a moſt excellent ſolvent in chemiſtry, whereby bodies are diſſolved into their ſmalleſt and moſt active parts, without impairing their ſeminal virtue; ſo as to gain them entrance into the innermoſt receſſes of the body, in order for conquering the moſt obſtinate diſtempers. It is no leſs ſerviceable when externally uſed in wounds, tumours, and ulcers. And that the poor may not want ſo excellent a remedy, it may be directly prepared by mixing pot-aſhes, with fifteen times their weight of ſtrong vinegar, then ſtraining and inſpiſſating the ſolution; and thus, without loſs of labour, or great expence, a medicine may be eaſily prepared for uſe. And this medicine was known to the ancient *Romans*, and is mentioned by *Pliny* in his preface, where he ſays, *the aſhes of vine-twigs, being diſſolved in vinegar, is drank in diſeaſes of the ſpleen.*

PROCESS LXXIX

Harvey's *tincture of ſalt of tartar.*

'TAKE the black alcaline ſalt, remaining in the retort after the ſtrongeſt diſtillation of tartar, according to the fifty-fifth proceſs; reduce it to powder, in a hot iron mortar, with a hot peſtle, and immediately put it into a tall bolt-head; pour the beſt common ſpirit thereon, ſo as to riſe four inches above it; boil with a gentle fire in our little wooden furnace, for twenty hours; and thus a black, thin, bitter, aromatic, lixivious liquor will be obtained, which, being decanted pure, may long be preſerved perfect in a cloſe glaſs for uſe, under the title of *Harvey*'s *tincture of ſalt of tartar.*

The uſe.

The common ſpirit, conſiſting of water, acid, and alcohol united, coming to boil with the alcali of tartar, that ſtill remains oily, makes a mild and ſafe lixivium; the alcali being here tempered by the acid, oil, and alcohol: whence we have a noble kind of medicine and menſtruum; wherein if vegetables be boiled or digeſted, it diſſolves them to good advantage. In chirurgery, it is an excellent remedy for cleanſing, deterging, drying, and healing all weeping, purulent, putrid, ſanious and virulent ulcers, as well the fiſtulous as the ſinuous and burrowing; and alſo for taking down proud-fleſh, eſpecially if artificially mixed with a little oil. It has ſimilar effects when uſed internally, in diſtempers where acid, auſtere, aqueous, mucous, or terreſtrial matters, and coagulations abound, provided they be not attended with a putrid diſſolution of the humours; and hence it is commended in old obſtructions of the *viſcera*, collections of water, dropſical diſpoſitions, the green-ſickneſs, jaundice, and cold gout. It acts ſtrongly as a diuretic, a

diaphoretic, and ſometimes as a purgative; and may be ſafely given in a large doſe. Two or three drachms thereof being mollified with an ounce of the ſyrup of the five opening roots, and diluted with fennel-water, will have a very good effect; being taken in the morning faſting, and repeated three or four times at due intervals, or a better than moſt other remedies. Hence the famous Doctor *Harvey* deſervedly recommends it; tho' the ancient phyſicians alſo were not unacquainted with the like for the ſame purpoſes, as may appear from *Dioſcorides* (*a*).

PROCESS LXXX.

Helmont's *tincture of ſalt of tartar.*

'TAKE the black ſalt of tartar remaining upon the diſtillation of 'tartar, put it into a large and ſtrong crucible, burn and calcine it 'well in the fire, with care to prevent the coals, or other matters falling 'into it, till it becomes white, and all its oily matter be conſumed: Or, to 'make more diſpatch, take a parcel of the beſt tartar, and tie it up in cap-'paper, firſt made a little moiſt, then put it into the fire, and ſurround it 'every where with live coals, and let the fire at laſt go out of itſelf; then 'removing the hot aſhes, an alcaline ſaline maſs will be found run together 'at the bottom: this is called common ſalt of tartar. Let either of theſe 'preparations be diſſolved in water, filtred and exhaled away in a clean iron 'pot, after the Manner deſcribed in our twelfth proceſs, and let the ſalt 'be afterwards calcined in the ſame manner, as is there deſcribed, and be 'reduced to fine powder, which the finer it is, the fitter it will be for the 'purpoſe: this will be excellent ſalt of tartar. Then have ready at hand a 'tall and dry chemical glaſs, with a wide mouth, one third full of pure and 'warm alcohol; let alſo the whole neck of the glaſs be well heated all 'round, leſt it ſhould burſt by the heat of the ſalt of tartar, to be now 'preſently poured in; fit a paper funnel to the mouth of the glaſs, and 'thro' this pour the powder of the ſalt of tartar now extremely hot, as it 'comes from the fire, and therefore dry, into the alcohol. If all theſe 'particulars are rightly obſerved, the ſalt will fall into the alcohol with a great 'hiſſing and noiſe, and immediately cauſe an ebullition. When a ſufficient 'quantity of ſalt is put in, ſtop the glaſs ſlightly with a cork, and when all 'is cold, pour in more alcohol, till the glaſs be three fourths full; ſhake 'them together, ſo that no ſalt may hang on the ſides of the neck of the 'glaſs, but all of it remain entirely under the alcohol, otherwiſe theſe adhering 'particles of ſalt would diſſolve by the moiſture of the air; then mix them-'ſelves with the alcohol, and fruſtrate the whole laborious operation. Let 'the glaſs now be ſet in a heat of a hundred degrees, and be kept often 'ſhook, and lightly ſtopped to exclude the moiſture of the air, which is 'here ſo prejudicial. The liquor will thus ſoon become of a deep and 'beautiful red colour, and contain the maniſeſt virtue of the alcaline ſalt,

(*a*) See *Dioſcorides* book I. p. 186.

'as

'as appears by the fmell and tafte, tho' fcarce by any effervefcence, but 'efpecially if it be very cautioufly infpiffated by diftillation: for being afterwards examined, it is found manifeftly faponaceous, and fomewhat faline. If the leaft particle of water be mixed with either ingredient, no 'tincture will be obtained, but the alcohol remain colourlefs, and tranfparent upon the alcali, how long foever they ftand together. And thus even 'the lighteft fign of moifture will alfo appear; whence I do not wonder to 'find, that fome eminent chemical authors have wrote, that this tincture 'was impoffible; for it cannot be made if any one, even of the flighteft 'circumftances here required, be omitted. And as to what other profeffors 'of the art have wrote, that the colour, by our method communicated to 'the alcohol, fhould be owing to a fpontaneous change thereof in time; 'this is confuted by the experiment itfelf, and the marks above defcribed: 'but it is eafy to miftake in fo laborious and difficult an experiment. I have 'not found the tincture alcaline, but rather of a compound, faponaceous 'nature.'

The ufe.

This experiment again fhews, that pure fixed alcali has an appetite of attracting almoft all liquids to itfelf, whenever it exifts by itfelf. Thus it greedily drinks in water, acids, and oils, as appears by the proceffes above performed; and in our prefent procefs it drinks in alcohol alfo, tho' not fo ftrongly, or fo clofely, as the former. And hence we have a new method of making an extremely fubtile foap of alcali and alcohol; for this tincture is truly faponaceous, as appears by rubbing it between the fingers, where it has a manifeft, detergent property, in a high degree; whilft pure alcohol, thus treated, would manifeft itfelf only by drinefs. It fhews itfelf to be faline and fiery by its tafte; it does not, indeed, make a manifeft effervefcence with acids, or readily precipitate bodies diffolved therein. If the pure tincture be infpiffated by diftillation, it leaves a faline, faponaceous, fcarcely alcaline, but fharp, coagulated fubftance at the bottom, of a deep red, or almoft black colour. As a menftruum, it incomparably diffolves all diftilled oils with great expedition and perfection; it likewife extracts excellent tinctures from gum-lac, myrrh, and amber: it is recommended by the chemifts for internal ufe, againft diftempers arifing from a ftubborn tartarous matter: but to fay the truth, it cannot be given, unlefs diluted with water, wine, or the like mild liquor, otherwife, it inftantly burns the parts it touches; and when weakened, as it requires, to what purpofe was all the pains taken to purify the alcohol, and unite it with the alcali? I judge, therefore, that the preceding procefs affords a more excellent medicine, with much lefs trouble. The prefent operation, however, is by no means ufelefs; for it teaches many particulars, fome whereof are mentioned above, and others we now proceed to mention.

I have long confidered upon that cafual faying of the great *Helmont*, that if fpirit of wine be diftilled from thoroughly calcined falt of tartar, one half of it will be turned to water. This I underftood of fpirit only once rectified; efpecially, becaufe in another place, he fays, the fame thing happens with vinegar, as was above obferved under the forty-ninth procefs. But becaufe

the principal followers of *Helmont* declare, that we are to underſtand this ſaying of pure alcohol, one half whereof is joined to ſalt of tartar, whilſt the other is turned to water; and therefore that true alcohol conſiſts of theſe two ſeparable parts; and alſo that the ſalt of tartar is thus likewiſe converted into that noble balſam, or *ſamech*, of *Paracelſus*, which miraculouſly heals wounds without any inconvenience; I judge proper here to declare what I have my ſelf found with great labour. I made a perfect tincture of the ſalt of tartar, in the manner above deſcribed; it was extremely ſtrong, red and fragrant, and of a ſharp, fiery, and almoſt alcaline taſte; I digeſted it upon its alcali for many months, then ſet it by for four years; the ſalt continued extremely dry at the bottom, and the tincture exceeding red above it: I then poured out all this ſalt, and the tincture, into a perfectly dry, and clean glaſs body; they were extremely fragrant: I diſtilled off all the alcohol with a gentle fire, having exactly luted the junctures; the alcohol was perfectly limpid, ſubtile, and fragrant; the ſalt at the bottom was now of a purple colour, tho' it was white before; I poured the alcohol upon its ſalt, and diſtilled as before; the alcohol now roſe with more difficulty, and a ſaline red maſs remained behind; the alcohol was of a fiery taſte; I thus continued to cohobate it for one and twenty times, after which, a black ſaline maſs remained at the bottom, and the alcohol came over exceeding ſharp; in the laſt place I urged this black, alcaline, ſtrong ſmelling maſs with the greateſt heat, that ſand would give, upon which there came over, not alcohol, but water, tho' I had with the utmoſt care prevented any water from getting in. And thus I found that water might be obtained from this ſalt and alcohol, but not half the quantity in reſpect of the alcohol; and ſtill I have ſome doubt whether this water did not proceed from the air, or was not ſecretly taken up upon returning and diſtilling the alcohol ſo many times over: this I am certain of, that the alcohol thus firſt put to digeſt with the ſalt of tartar, for ſo many months, and afterwards left for ſome years therewith, then drawn off from it two and twenty times, did not make this ſalt volatile, but left it fixed and perfectly black. Having now broke the veſſel, and taken out all the ſalt, I expoſed it, in a hollow glaſs, in a cellar, where it run into a brown liquor of a ſharp alcaline taſte, which I reſerved by itſelf. This labour I undertook, that I might at length be certain of the nature of ſalt of tartar, and of the converſion of alcohol into water by its means; the union of alcohol with ſalt of tartar, by diſtilling it therefrom; and the volatilizing of ſalt of tartar by means of alcohol: and hence we ſee what the great promiſes made about theſe matters end in. The alcohol, ſo many times cohobated, was extremely clear, fragrant, of a fiery taſte, would burn away without leaving any fæces, and made no kind of efferveſcence upon the addition of acids: and this was the reward of my labour.

PROCESS

PROCESS LXXXI.

Elixir proprietatis *with distilled vinegar.*

'TAKE choice aloes, saffron and myrrh, of each half an ounce, cut and 'bruise them, put them into a tall bolt-head, pour twenty times their 'own weight of the strongest distilled vinegar thereon, let them simmer together in our little wooden furnace for twelve hours: now suffer the whole 'to rest, that the fæces may subside, and gently strain off the pure liquor 'thro' a thin linen. Put half the quantity of distilled vinegar to the remainder, boil and proceed as before, and throw away the fæces. Mix the 'two tinctures together, and distil with a gentle fire till the whole is 'thickened to a third; keep the vinegar that comes over for the same use; 'and what remains behind is the *elixir proprietatis*, made with distilled 'vinegar.'

The use.

Thus we obtain an acid, aromatic medicine, of great use in the practice of physic; for when externally applied, it cleanses and heals putrid, sinuous, and fistulous old ulcers, defends the parts from putrefaction, and preserves them by a true embalming virtue: it also heals ulcers, and cures gangrenes in the lips, tongue, palate, and jaws. It has the same effects in the first passages, when used internally, as often as putrefied matter, corrupted bile, concreted phlegm, worms, and numberless distempers proceeding from these four causes, are lodged or seated therein. Again, it has nearly the same effects in the blood and *viscera*, as may easily appear from knowing the virtues of the three ingredients, when dissolved in a subtile vinegar. It is to be taken in a morning upon an empty stomach, at least twelve hours after eating: it is given from a drachm to two or three for a dose, in sweet wine, mead, or the like; walking after it, or having the belly gently rubbed. If taken in a larger dose, and with a somewhat cooler regimen, it always purges; if in a less dose, and often repeated, it cleanses the blood by secreting thick urine; and generally performs both these operations successively. But, if taken plentifully, while the patient is in bed, and the body well covered, it acts as an excellent sudorific; and afterwards usually purges, and proves diuretic, and thus becomes every way useful: whence I conceive that this is the best acid *elixir proprietatis*, good in numerous cases, and at the same time safe. *Paracelsus* declared, that an elixir made of aloes, saffron, and myrrh, would prove a vivifying and preserving balsam, able to continue health and long life to the utmost possible limits; and hence he calls it by a lofty title the elixir of propriety to man; but concealed the preparation, in which *Helmont* asserts the alcahest is required. *Crollius* formerly used the oil of sulphur made by the bell, as a menstruum in this case, upon considering, according to the doctrine of *Paracelsus*, that an hungry acid was proper in stomachic remedies; but when this is used, the aloes and myrrh are scorched; and acquire a stony hardness, so as not afterwards readily to dissolve

diſſolve in alcohol: for this uſe they require that the ſtrong acid of the ſulphur ſhould be diluted. Hence I conjectured, that a mild, oily, vegetable acid would prove a commodious and proper ſolvent in this caſe for medicinal uſes; and upon adding an equal quantity of alcohol to the elixir prepared in this manner, it becomes more balſamic, mild, and effectual. It in every reſpect reſembles the *Pilulæ Rufi*, and may be ſucceſsfully uſed in their ſtead.

PROCESS LXXXII.

Elixir proprietatis *with a diſtilled water.*

'REDUCE equal quantities of aloes, ſaffron, and myrrh, to powder; 'put it into a tall chemical glaſs, add twenty times their weight of 'diſtilled ſcurvy-graſs water, and proceed as in the preceding proceſs.

The uſe.

This elixir, tho' excellent, has this inconvenience, that when long kept, it grows mouldy; but it has extraordinary virtues in the body, like thoſe deſcribed in the laſt proceſs, excepting that it wants the acid. It is an excellent purge, and inſtead of ſcurvy-graſs water, any other aromatic water may be employed.

PROCESS LXXXIII.

Elixir proprietatis *with fixed alcali.*

'TAKE the ſame ingredients as above, put them into a bolt-head, and 'pour as much oil of tartar *per deliquium* to them, as will make them 'into a moderately thin paſte, which is to be digeſted in our little wooden furnace, with the heat of a hundred degrees: the longer the digeſtion is 'continued, the better, the veſſel being ſtopped: and thus in time the alcali will intimately diſſolve the aloes and myrrh for this purpoſe. When 'the matter is thus prepared, let it be treated with any diſtilled aromatic 'water, as deſcribed in the preceding proceſs; and thus there will be obtained an alcalized *elixir proprietatis*, with a diſtilled water. Or elſe, to the 'ſpecies, prepared as above, add twenty times their weight of pure alcohol, 'and boil them for twelve hours after our manner; when cold, carefully 'pour off the upper liquor from the fæces; add more alcohol to the remains, and proceed as before, till all the virtue be drawn out; then thicken 'the tinctures together by gentle diſtillation, till the liquor acquires the conſiſtence of oil of almonds; and keep it under the title of *elixir proprietatis* 'with alcali and alcohol: the virtues of which preparation cannot be ſufficiently recommended: or if inſtead of alcohol, common ſpirit be uſed, a 'thicker,

'thicker, and no lefs noble elixir will be obtained. In this preparation, I 'have fometimes ufed inftead of alcohol or fpirit, the fimple or compounded 'fpirit diftilled from aromatics, as in the fixty-ninth, feventieth, feventy-'firft, and feventy-fecond proceffes; and the elixir, fo prepared, has proved 'excellent, efpecially when made with the compound fpirit of the feventy-'fecond procefs.'

The ufe.

Thefe elixirs are of frequent and excellent ufe in all diftempers proceeding from auftere, aqueous, cold, phlegmy, and fcirrhous caufes, or uninflammatory obftructions; they purge nearly by all the emunctories of the body, and are at the fame time grateful to the nerves and fpirits. They excellently forward the birth, promote the menfes, bring down milk, kill worms, and fupply the defect of the bile; whence practitioners cannot be without them. They act by means of the alcali, the diffolved ingredients, the fpirit, and the waters employed, in various ways.

PROCESS LXXXIV.

Elixir proprietatis *with tartarifed tartar.*

'TO the fame ingredients, reduced to powder, pour thrice their weight 'of the liquor of tartarifed tartar, made according to the feventy-'feventh procefs; digeft them in a clofe veffel for three days, in a heat of 'a hundred and fifty degrees; and thus the ingredients will be entirely 'diffolved into an uniform pappy mafs, much better than by vinegar, 'water, or alcaline liquor. Then pour on twenty times the quantity of 'alcohol, in refpect of the ingredients, and boil them gently for twelve 'hours: let all cool and ftand at reft, then decant the clean liquor, and treat 'the reft with more alcohol, as before, till nearly the whole be diffolved: 'for little fæces will here be left. Infpiffate all the elixirs together, with 'a gentle fire, to the thicknefs of oil; preferve the alcohol for the fame 'ufe; and thus will be obtained the *elixir proprietatis* with tartarifed tartar 'and alcohol.

The ufe.

This elixir being prepared with a compound, and wonderfully opening falt, has greater virtues than the foregoing; fo that it is admirable in old inveterate obftructions, which it powerfully refolves, without offending by any acid or alcaline property: for thefe compound falts, along with what they diffolve, generally pafs quick thro' the veffels of the body.

PROCESS LXXXV.

Elixir proprietatis *with regenerated tartar.*

'PUT the above-mentioned ingredients into a tall glaſs, and pour 'thereto thrice their weight of the liquor of regenerated tartar; di- 'geſt for three days, and the aloes and myrrh will be thus almoſt entirely 'diſſolved, and the ſaffron thoroughly open'd; then add twenty times the 'weight of pure alcohol, with reſpect to the powder, boil them gently for 'twelve hours, and in other reſpects proceed as before; there will remain 'a few fæces, which may be thrown away. Inſpiſſate the elixir to an half; 'reſerve the alcohol for the like uſe; the elixir will be and always continue 'thick and turbid.

The uſe.

In this laſs proceſs the ingredients are almoſt wholly diſſolved, ſo as to become uniform and potable; whence I have found this elixir to have an incomparable opening, and diſſolving virtue in moſt chronical diſeaſes, where it mightily liquifies the concretions in the veſſels, agreeably ſtimulates the nervous ſyſtem, ſo as to throw off the matters thus diſſolved, and prevents putrefaction, which in theſe caſes is ſo frequent and deſtructive. Hence it relieves the *viſcera*, reſtores their actions impaired by an obſtructing matter, reſolves the tumours, and thus cures numerous diſtempers, ſcarce otherwiſe curable: whence I have been almoſt inclined to eſteem this elixir as the elixir of *Paracelſus* and *Helmont.*

In all theſe proceſſes we have an example of the chemical ſolution and preparation of the ſame thing, by various ſolvents; and learn by what means theſe ſolutions have different virtues, according to the difference of the menſtruum; and that theſe elixirs ought to be prepared with different menſtruums for daily uſe, according to the intention of the phyſician. So likewiſe they act differently, according as they are determined by the preſcriber. Thus, if taken with *Venice* treacle, they prove ſudorific; if along with a cathartic, they purge; and if along with whey, or mineral waters, they prove diuretic, provided the patient walk abroad in the cool air. They all of them preſerve the bodies of animals from putrefaction, if ſuſpended therein, except that prepared with water; they are all of them excellent in caſe of carious bones, except thoſe prepared with acids; and hence they ſhould always be ready at hand for practice, as being almoſt general medicines: and no wonder, ſince ſaffron is a true exciter of the animal ſpirits; aloes an excellent and innocent purgative; and myrrh the higheſt preſervative: but in thoſe diſtempers where the blood is too much broke, in large bleedings, or the hemorrhoids, or where the humours are in too violent a motion, they are by no means proper, but hurtful.

PROCESS LXXXVI.

The analyſis of ſoot.

'TAKE of the blackeſt and drieſt ſoot, gathered in the chimney of an 'oven where nothing but bread is baked, and gathered on a very 'fair day; with this fill a large glaſs retort almoſt to the neck, apply a large 'glaſs receiver, after the neck of the retort has been thoroughly cleanſed on 'the inſide, and lute the juncture with the common linſeed paſte; raiſe a 'fire of a hundred and fifty degrees, and keep it up equably: a large quan-'tity of tranſparent water will thus come over, with conſiderable violence; 'ſo that if the fire was immediately made ſtrong at firſt, the receiver would 'eaſily crack. Continue in this manner, ſo long as any clear water comes 'over, which it will long do, altho' the ſoot was dry. Then taking away 'this firſt water, and pouring it into a glaſs, apply the receiver again, and 'raiſe the fire a little above two hundred degrees; a white, milky, fat 'water will now come over in quantity, and with conſiderable violence; 'proceed with a ſlowly increaſed fire, ſo long as this continues; keep it 'apart, apply the receiver again, and raiſe the fire briſkly; a yellow, vola-'tile, copious ſalt will come over, and ſtick all round the ſides of the re-'ceiver; continue the fire thus briſk, ſo long as any ſalt riſes; then with the 'ſtrongeſt heat, that ſand will give, and with the heat of ſuppreſſion, there 'riſes a thick black oil. Let all cool, and there will be found, in the neck 'of the retort, a ſalt which could riſe no higher, even by ſo violent a fire; 'but in the bottom of the retort there remains a black feculent matter, the 'upper ſurface whereof is covered with a very thick, whitiſh, ſaline cruſt, 'which both in colour, figure, concretion and *ſtriæ*, reſembles the com-'mon ſal-ammoniac. If the milky water be rectified, it affords a very 'penetrating volatile ſpirit, and ſome ſharp volatile oily ſalt.

The uſe.

This proceſs was abſolutely neceſſary, becauſe all the foregoing only exhibited thoſe parts of vegetables, which, being treated by various preparations, and different degrees of fire, either remained fixed, or were tranſmitted from one veſſel into another. But here we are taught what the agitation of an open fire can move, change, expel, and drive thro' the air by burning, firſt in the form of ſmoke, then of flame, laſtly of exhalation, and how high it may carry them. For a chimney is a kind of ſtill-head, converging in an open top, and ſometimes riſes to the height of above thirty feet, and carries ſoot up to the top, and after this diſcharges a black ſmoke, at its upper orifice, and diſperſes it thro' the air, where it ſeems gradually to vaniſh. It may deſerve to be conſidered, what an immenſe quantity of ſuch matter is, by the force of fire, thrown up from the ſurface of the whole habitable globe, in the places where fire is conſtantly uſed; whence we may learn, that combuſtible vegetables, their ſmoke, flame, and ſoot, and the black clouds diſperſed in the air, conſiſt of one and the ſame matter, agitated

by fire. This matter confifts of feveral parts, *viz.* (1.) A fetid, oily, bitter, unpleafant, naufeous fpirit, refiding in the water, that firft comes over, and afterwards conftantly difperfed thro' all the other parts, which we fhall prefently enumerate. This fpirit feems to be the oily, and more fubtile part of the vegetable, acted on by the force of fire. (2.) Water, which is here contained in great plenty, as refiding in this fpirit, in the firft limpid, and in the fecond milky liquor, as alfo in the faline fpirit, the volatile falt, and in fome meafure in the oil itfelf. This water can fcarce be rendered pure by any art; being always fouled with the unalterable bitternefs, and the infeparable difagreeable odour of the fpirit. (3.) A fharp, volatile, alcaline, oily falt, which firft comes over, rifes into the receiver, and fticks to the fides thereof; for this falt is truly alcaline, as appears by its tafte, fmell, fiery virtue, the violent effervefcence it makes with acids, and by concreting therewith into a compound falt: and hence a volatile alcali continually impregnates the atmofphere, in great plenty, by conflagrations. (4.) A fharp, alcaline, fat fpirit, confifting of the falt juft now mentioned, diffolved in water, and fo refembling fpirit in fluidity, pungency, fubtilty, and volatility. (5.) A fetid, black, bitter, naufeous, inflammable, thick, and almoft cauftic oil, mixed with an oily falt. (6.) A true fal-ammoniac, fticking in the lower part of the neck of the retort, and raifed to the furface of the black earth below. For if this falt be carefully collected, and feparated from the alcaline kind, that firft comes over, it proves a genuine fal-ammoniac. It is of a whitifh colour, fomewhat tranfparent, makes no effervefcence with acids, and, if mixed with fixed alcalies, prefently affords a true, volatile, alcaline falt, as fal-ammoniac does; whence the true origin of this falt is derived from foot. (7.) A black, fixed earth, which being afterwards calcined in an open fire, and burnt from its oil, that tenacioufly cleaves thereto, leaves a white earthy calx behind.

This is the analyfis of foot, by confidering of which we may learn what parts of vegetables are volatile, and fly off by an open fire, and what are fixed and remain behind; and what fire throws off from vegetables into the air. Hence we fee, that even earth, which appears fo fixed in the moft violent fire, after being feparated from the other principles, yet when mixed with the reft, is either by the force of flame, or fire, thrown to the diftance of forty feet thro' the air, in the form of a thin cloud; but there would be no end, if we fhould minutely purfue the phyfical ufes of this procefs. Pills compofed of dry foot, and gilded, are recommended for the cure of cold diftempers, and this often with fuccefs. The volatile falt of foot is ufed with the fame fuccefs, as that of animals. *Hartman* recommends the falt that rifes laft, for giving relief in cancers; and certainly fal-ammoniac, prudently employed, is of fervice againft the putrefaction of running cancers. But the foot produced by oak-wood alone, the common *Dutch* turfs or pit-coal, appears different upon chemical analyfis: and that again would be very different, that fhould be collected from the chimney of a public kitchen, which is continually filled with the fumes, not only of the fewel, but likewife of all kinds of boiled, roafted, and fried meats. And thus much may help us to form a right judgment of foot.

PROCESS

PROCESS LXXXVII.

The analysis of amber.

'TAKE a capacious glafs-retort, with its neck cut off, fo as to leave an
' orifice two inches wide or more; put into it pieces of common am-
' ber, well cleanfed from fand, duft, or other foulnefs, fo that it may fill two
' thirds of the cavity. Apply a large receiver, and lute the juncture with the
' common luting; diftil in a fand-furnace, with a degree of heat a little
' greater than that of boiling water; thus there will come over a copious, thin,
' limpid oil: continue this degree of heat fo long as any oil comes over,
' and keep it feparate. Then apply the receiver again, and cautioufly raife
' the fire, till a fecond oil begins to rife, which will be yellow, large in
' quantity, and ftill tranfparent: proceed patiently with the fame degree of
' heat, fo long as this oil comes over, which it continues to do for a confi-
' derable time: but for the elegance of the operation, this alfo might be
' kept feparate. Now, again, raife the fire gradually, till a white, faline,
' woolly matter appears in the receiver, but particularly in the neck: then
' gradually raife this fire a little, and continue it increafing, till no more
' of this matter comes over; but the fire muft not be increafed too quick,
' otherwife the volatile falt would mix with the grofs oil that fhould
' follow after, and thus be in a great meafure loft therein. It is beft to re-
' move the receiver, take out the productions, and keep them feparate;
' but during the whole time that this volatile falt rifes, a red oil alfo comes
' over, ftill almoft tranfparent. The fire being now increafed to the utmoft,
' there comes over a grofs, vifcous, fat oil, thick like turpentine. When
' this is rifen, if a fire of fuppreffion be given, the whole black matter, now
' becoming flatulent, rifes into the neck of the retort, and thus comes into
' the receiver, in form of a hard, black mafs; fo that if the neck of the
' retort is not left wide, it will be thus blocked up, and the glafs be
' burft in a dangerous manner, with a loud noife, and often a firing of
' the matter. But if before the fire of fuppreffion was ufed, a large quan-
' tity of fand were thrown upon this laft remainder, it will divide the
' matter, and caufe it to come over, without danger, in a black and dry
' form. There remain at the bottom of the retort, a very fmall quantity
' of brittle fæces, of fcarce any fignificance; fo that the whole is volatile.
' If the operation be carefully performed, fo many different productions are
' obtained, which may be purified by a new diftillation, and be rendered
' thin and limpid; but the volatile falt, collected by itfelf, is perfectly acid.
' And this is the only method that I know wherein a true acid is obtained
' in a folid faline form; for we have no inftance thereof in any other vege-
' table, animal, or foffil fubftance: For tartar is a falt fcarce foluble in
' water, tho' it be acid. Oil of vitriol, brought to an extreme degree of
' purity, fhoots in winter time into tranfparent folid cryftals, but immediately
' diffolves again, and appears fluid as foon as the cold is a little diminifhed:
' but the falt of amber long continues the fame.'

The use.

Amber thus appears to be a very particular body; its oil reſembles the foſſil ones of *Petroleum*, *Naphtha*, and the like; but the remainder, after the firſt or ſecond is come over, nearly reſembles jet; and the acid ſalt ſeems ſomewhat vitriolic. Hence I have had a doubt where to place its analyſis; at length I placed it here as doubtful; that it might be reſolved into its parts; the rather becauſe it almoſt entirely diſſolves in alcohol, without ſeparating into its parts, as in the fifty-eighth proceſs. But the ſame thing concreted wonderfully differs from thoſe parts, into which chemiſtry reſolves it. Who will think that amber, its powder, its liquid ſolution in pure alcohol, the powder precipitated from its tincture with water, after diſtillation, and then waſhed; the oils, ſalt, and colophony, after diſtillation, proceeded from the ſame matter? Who could know the proper virtues of each; and who, by joining them together again, could recompoſe amber? The oils, being purified by a repeated diſtillation, have a ſharp, balſamic, exciting, diaphoretic, diuretic, emmenegogic, and hyſteric virtue; and, when externally uſed, in the way of liniment, are very ſerviceable in reſtoring contracted, weak, paralytic, torpid limbs: the volatile ſalt is gratefully acid, balſamic, unctuous, penetrating, preſervative, and ſtimulating to the nerves and ſpirits, being a true, volatile, acid, oily ſalt; and therefore a capital anti-hyſteric and diuretic; eſpecially, if purified by a ſecond diſtillation.

PROCESS LXXXVIII.

The Putrefaction of vegetables.

'IF the ſoft, freſh, and juicy parts of vegetables, be in the ſummer-time 'thrown into an open caſk, and preſſed down therein, that the veſ'ſel may be almoſt full, and then left thus in the open air, they will ſoon 'of their own accord, begin to grow warm, and continue to do ſo more 'and more every day, eſpecially in the middle. This heat, at length, in'creaſes above that of boiling water, and proves ſo much the more violent, 'the more the matter was compreſſed, and the leſs aqueous the plants, pro'vided they were not dry. After this heat is arrived to its height, it 'again decreaſes by degrees, and returns to the temperature of the atmo'ſphere: and by this means, the whole maſs of vegetables is reduced al'moſt to an uniform, pappy maſs. This heat begins in the middle of the 'heap, where it is greateſt, and thence ſpreads itſelf every way, till at 'length it poſſeſſes the whole. It makes no difference what plants are em'ployed for this purpoſe, whether the moſt alcaline, as ſcurvy-graſs; the 'moſt acid, as ſorrel; or the moſt inſipid, as graſs. Theſe plants firſt 'breathe their own odour, if they were fragrant, ſo long as the heat conti'nues ſmall, or not above eighty degrees; and ſo long their particular taſte 'remains; but as the heat becomes gradually greater, the natural odour is 'changed into that obſerved in hay that grows hot, upon being ſtacked too

'wet;

'wet; and laftly, the heat coming to its height, all the peculiar fmell, 'tafte, and even the colour of the plant is loft; a putrid, fetid, ftercorace-'ous fmell, and a cadaverous, putrefied tafte, refembling putrefied urine, are 'produced, the prefiding fpirit is loft; and the fmell and tafte are the fame, 'tho' the plants were ever fo different. If the plant be frefh cut, half 'dried, or ftill otherwife, retains its natural juices, and be thrown into large 'heaps, a fharp and very diffufive odour will firft arife; which fhews that 'the fiery motion is beginning in the inward part of the heap, where the 'compreffion is the greateft, whilft no heat is yet perceived on the out-'fide. If now the whole heap be thrown abroad, and the plant cooled, the 'putrefaction is prefently ftopped; but if left to itfelf in the heap, the 'heat increafes, fo as to rot all the infide, boil in the middle, and at length 'break out into open flame; and the larger the heap, and the greater the 'weight, the fooner this putrefaction and fire is produced. If the matter 'thus takes flame, it is changed, as it would be, by burning under a chim-'ney; but if it be ftrongly heated, tho' not fo far as to fire, it then per-'fectly putrefies into a pap, as in the cafe we have defcribed: and hay is 'too frequent an example hereof. This action comes on the flower in ve-'getables, the more dry they are of themfelves, or the more they have been 'dried; but if moiftened with an additional quantity of water, fo as to 'grow thorowly wet, the putrefaction will renew in them again. It 'alfo proceeds the flower, the lighter the matter lyes upon itfelf, fo as to 'leave fpaces that admit the free air; but it proceeds the more ftrongly, 'the fofter the fubject, and the more violently compreffed. Whence the 'drier plants, fuch as rofemary, being put up into a cafk, will fcarce putre-'fy in the manner above defcribed, unlefs ftrongly preffed down by weight, 'or unlefs the heap were large. On the other hand, if too aqueous, a cer-'tain corruption, but not this heating action, is ufually produced. If this 'pappy mafs, fo prepared, be immediately put into a large glafs body, and 'diftilled, with the junctures well clofed, almoft to drynefs; a limpid, fetid 'liquor will come over, that fhould be kept feparate. Put the remainder, 'now almoft dry, into a glafs retort, and diftil with degrees of fire, to the 'higheft that can be given in fand; and thus it affords white fumes, a large 'quantity of liquor, a white falt, and a black thick oil; all to be kept apart. 'There remains behind a very fmall quantity of black fæces, which being 'taken out, and burnt in the open fire, leave a mere earth, without any 'fixed falt behind; tho' this falt might be obtained, in plenty and perfec-'tion, from the fame plants before putrefaction.

'If, when the oil is feparated, the laft liquor be, with a gentle fire, diftil-'led, in a tall veffel, to an half, it affords a fharp, alcaline, faline, volatile 'fpirit; which again being diftilled to an half, becomes much ftronger. 'And if the operation be repeated in a clofe veffel, a liquor will at length 'be obtained, extremely like rectified fpirit of hartfhorn: and afterwards 'by a gentle fire, a true volatile falt, in greater plenty than the plant would 'have afforded, of fixed falt by burning, before putrefaction. The like 'fpirit and falt may be alfo obtained in the fame manner, from the former 'liquors; and when thoroughly purified, they perfectly refemble the vola-

'tile

‘ tile ſalt, and ſpirit of animals, without the leaſt chemical difference ; and
‘ this happens, even tho' the plant were of the moſt acid kind. The oil,
‘ forced over by the laſt extremity of the fire, is black, thick, and intoler-
‘ ably and laſtingly fetid ; in which reſpects, as alſo in its pitchy tenacity, it
‘ extremely reſembles that which, by the utmoſt violence of fire, is ſeparated
‘ from animal ſubjects.

The uſe.

The action above explained is called putrefaction ; which, without the aſſiſtance of art, ſpontaneouſly happens in vegetables, as often as they are thrown on large heaps, or compreſſed in a moiſt ſtate. This action is general, and converts all vegetable ſubjects into the ſame matter, how different ſoever they were at firſt. It alſo makes the whole of them volatile, except a little earth ; whence no operation more fills the atmoſphere with ſharp and often peſtilential effluvia ; as we may learn from the fetid ſmell of putrefied bodies, which ſpreads ſo wide, and gives men notice to beware of ſuch infected places. And as this putrefaction intimately reſolves both the fluids and ſolids, ſooner or later, into a liquid, ſoft, ſoluble maſs ; it eaſily appears that by means thereof, and by the aſſiſtance of diluting rains, all things may be returned into the pores of the earth, from whence they before proceeded : or elſe, being carried up into the air along with the dew, miſt, hail, ſnow, or rain, be again returned to the earth : or elſe putrefying thereon, ſink into it along with the water that falls in rain. And in all art or nature we find no operation ſo univerſal ; as acting upon every vegetable in the ſame manner, with the ſame effect ; and reducing acid, auſtere, alcaline, aromatic, hot, cold, oily, phlegmy, and ſaline plants, to the ſame thing ; thus abſolutely aboliſhing all their particular ſtructures, odours, taſtes, colours, virtues, and making them all alike. The ſoft matter it brings them into is liquid, of a gray colour, and perfectly reſembling that gangrenous corruption, which is obſerved in putrefying, and rotting animal fleſh ; or approaching nearly to that change, which vegetables undergo in the living bodies of healthy animals, whilſt putrefied and diſcharged in the way of excrement. And the ſtronger the vital power of the animal is, or the more violent, thro' motion, or a fever, the nearer will the effects upon the vegetable aliment approach to the true vegetable putrefaction. Certainly, of all the natural and artificial operations, putrefaction beſt explains the firſt action of the mouth, ſtomach, and inteſtines ; whence that opinion is not to be entirely condemned, which makes the aliment to be there principally changed by putrefaction. This putrefaction is carefully to be diſtinguiſhed from fermentation ; the rather, becauſe artiſts every where too much confound them, to the detriment of arts. The differences appear to be theſe, (1.) A greater groſſneſs, compreſſion, and denſity, ſeems required in the putrefaction, than in the fermentation of vegetables. (2.) Putrefaction acts upon all vegetables whatſoever, provided they be ſoft and juicy ; but fermentation only upon ſome, and not upon others. (3.) The heat required in putrefaction ſpontaneouſly riſes from the degree of an healthy human body, even to that of a violent flame ; but in fermentation, if the degree of heat riſes up to that of an healthy

healthy body, the fermenting caufe is diffipated, and the liquor turned vapid; for the heat, generated by fermentation, is not greater than that of feventy five degrees, except in the fermentation of vinegar; and even there, unlefs the heat be immediately ftopped, no vinegar, but a corrupt vapid liquor will be obtained. (4.) Putrefaction renders all the faline matters volatile and alcaline, the oils fetid and volatile, and almoft volatilizes the earth itfelf: but fermentation makes acids volatile, and fubtile, and, contrary to alcalies, fpirituous, gratefully odorous and inflammable: it generates an acid tartar, that leaves an alcaline matter, as fixed in the fire as the fubject would have done before. (5.) The falts that by putrefaction are of the fame fimple, alcaline, fetid, volatile nature, are by fermentation acid, in great meafure fixed, and compounded of fpirit, oil, and earth. (6.) Putrefaction is a means of entirely converting all the faline vegetable matters, into one and the fame fimple, volatile alcali; but fermention converts only a certain little part of the faline matter of vegetables, into a liquid, volatile acid, leaving the reft almoft unchanged. But if after well confidering all thefe particulars, any one fhall think, that the two operations fhould not be diftinguifhed, to prevent multiplying differences without caufe, I have no oppofition to make; as not knowing what other kinds of arguments to ufe in chemiftry. Fermentation, with a fmall degree of heat, refolves the latent air, which, with the affiftance of the other elements, attenuates, moves, and diffolves the vifcid parts of the fermentable fubject, during a certain fpace of time, fo as to make a continual ebullition, and either to fet free, or generate an inflammable fpirit: but putrefaction, by a ftronger heat, agitates, and expels the fame air fuddenly, and fo changes the whole matter. It muft be obferved, that we have here fpoke only of vegetable putrefaction. And here we end our proceffes upon vegetables; as this laft has changed them into a form fimilar to that of animal juices, to which we are therefore led: but for more upon the fubject of putrefaction, fee the excellent Dr. *Cox*'s papers in the *Philofophical Tranfactions* (*a*).

(*a*) N°. 100, and 101.

PART

PART II.

Chemical Operations upon ANIMALS.

PRELIMINARIES.

IT appears by the preceding eighty-eighth procefs, that vegetables may be, and frequently are changed into one and the fame almoft undiftinguifhable fubftance; without any difference, whether the fubject were acid, alcaline, bitter, aromatic, infipid, poifonous, *&c.* and the fame thing happens in the vegetables received by animals as food. Hence therefore the preceding proceffes upon vegetables will lead us to underftand, what chemiftry may perform upon the parts of animals: but to proceed herein with better advantage, we muft here lay down a few particulars from medicinal hiftory.

1. All the known animals continually wafte, in all the folids and fluids whereof they confift at a certain time: this appears from the hair, nails, external fkin, the extremities of all the veffels, the internal fides, and the external furfaces thereof. This continual lofs is occafioned by the difcharge of very fine worn off particles, that do not appear, or elfe are efteemed as fluids. And thus the perfpirable matter, the fweat, the faliva, urine, milk, *&c.* are continually thrown off from the bodies of both fexes. Fractured bones are joined again in a few weeks, even tho' part of their fubftance were loft; which evidently fhews that even this folid part is in continual motion by means of the vital powers.

2. Animal bodies therefore do not in this refpect remain the fame that they were, but new matters are daily fupplied, in the room of thofe difcharged, by means of the food, and perhaps of the air taken in; for *Bellini* has obferved, that eggs gain in weight whilft fat upon by the hen. Hence it is manifeft by what the body is nourifhed, as it grows from a weight fcarce exceeding that of a grain, to the bulk we find it at full ftature: for, certainly, its growth proceeds from what is taken in, changed, worn off, and repaired by the vital powers.

3. The food of animals is either derived from vegetables, or from other animals, and their drink from the fame, or from water. Foffils contribute nothing to this purpofe, unlefs it be falt; tho' life may be preferved without it, as appears by the examples of whole nations, the *Brachmans*, *Pythagoreans*, and others, who lived wholly upon vegetables and water, and were healthy and long lived.

4. Moft of the animals ufed for human food generally feed upon vegetables, fuch as oxen, deer, fheep, goats, hares, *&c.* The larger fifh, indeed, feed upon the lefs, or upon infects; and fome birds of prey feed upon other

other creatures or infects : yet vegetables generally give origin to the aliments of animals, either firft or laft. Whence we have firft examined vegetable fubjects, in the preceding eighty proceffes.

5. The human body, therefore, confifts of a collection, chiefly of vegetable matters; for tho' we ufe milk, cheefe, butter, and flefh, yet the creature, that affords them, was before made up of grafs, hay, and water.

6. The chemift, before he examines an animal body, which is wholly fed by vegetables, fhould firft underftand what vegetables are, when treated by his art. If this be neglected, he will err in the knowledge of animal bodies; and hence it is that fo much confufion has arifen in this matter.

7. When all the changes of vegetables, producible by the art of chemiftry, are explained; the nature of that animal matter is firft to be examined, in the chemical treatment of animals, which being of a vegetable origin, begins to lofe its own nature, and to put on that of the animal; and this part is to be fuch as may be obtained and examined feparate, fo that the fucceffive change may be underftood; and chiefly whilft it retains much of its former nature; for thus the nature of the animal will by degrees be better learnt, efpecially that of the human body, for the fake of which all the labour is undertaken, than if a part, which had already undergone the actions of the whole body, were immediately chofe for the firft examination, as it ufually prepofteroufly is.

8. An animal is compofed of matter, which was not that animal before, but is changed into it by the vital power of the animal. This may be known by beginning with the firft change above-mentioned, and proceeding gradually thro' all the fucceffive natural changes, in their true and proper order. After long confidering where to begin thefe proceffes, at length, I found, they could not begin with the contents of the ftomach; becaufe the matter, as foon as it is herein changed, goes out in the form of chyle: and the contents of the inteftines want the part that was fo changed. The chyle of the mefentery, or thoracic duct, can fcarce be obtained in fufficient quantity; and, befides, it is in great meafure the lymph of the lymphatic veffels. Milk, therefore, appeared to be the firft thing to be examined; for this is a true chyle, and much lefs diluted with the lymph than the chyle when poured into the fubclavian vein, and therefore approaches nearer to the aliment. It has flowed thro' the veins, the heart, the lungs, and the arteries, and therefore been mixed with all the juices; and being afterwards feparated by the particular ftructure of the breafts, it may be collected and examined apart. Milk is a liquor prepared from the aliment chewed in the mouth, digefted in the ftomach, perfected by the force and juices of the inteftines, and elaborated by means of the mefentery, and its glands, and juices, and the juices of the thoracic duct; it has undergone fome actions of the veins, arteries, heart, lungs and juices, and begun to be affimulated, yet may ftill be had feparate, and difcharged out of the body.

9. And thus by their own milk, prepared from the proper matter of the chyle, all the known animals that have milk are nourifhed, both male and female. For milk is always prepared from the chyle, as well in men, as in women, as well virgins and barren women, as in mothers and nurfes.

Whence every ſuch animal conſiſts, is nouriſhed, and lives on its own proper milk; and from this alone prepares all the other parts, both the ſolid and fluid, by means of the vital actions. It is alſo certain, that men may live for years by feeding upon milk alone, and perform all the actions of life, and have all the ſolid and fluid parts of their bodies perfectly elaborated. The ſerum, therefore, the blood, the lymph, the ſpirits, bones, cartilages, membranes, and veſſels, proceed from milk; and if a man may live for years upon milk alone, milk muſt contain in itſelf the matter of all the parts in the human body. Milk approaches nearer to an animal nature than chyle; the chyle of the inteſtines is nearer to a vegetable nature, and that of the ſtomach neareſt: and hence we find the phænomena of fermentation and putrefaction in the ſtomach and inteſtines; ſuch as acid eructations, fetid ſmells, and the like; for this chyle is a true emulſion, prepared by the grinding of the teeth, the tongue, the ſtomach, and the inteſtines, along with the ſaliva, the liquor of the ſtomach, the pancreatic juice, and bile, in the inteſtines: and hence proceeds milk.

10. If this milk be good, and ſuffered to reſt in a clean veſſel, it firſt appears uniformly white, then throws up a white, thick, unctuous cream to its ſurface, and remains ſomewhat bluiſh, more tranſparent, thin, and leſs unctuous below. If the cream be carefully taken off, the remaining milk produces more, but retains a certain quantity behind. The ſame thing happens in emulſions; the milks of all the known animals have this property alike, as likewiſe the property of whiteneſs. The human milk is very ſweet and thin, the next is that of aſſes, then that of mares, then of goats, and laſtly of kine. Whence it is preſcribed in this order to conſumptive perſons of weak *viſcera*. But tho' milk reſembles vegetable emulſions in ſeveral reſpects, yet it is not the ſame thing therewith. The rennet, prepared of the juice in the ſtomach of ſuch creatures as chew the cud, being mixed with milk, coagulates it into an uniform maſs, that may be cut with a knife, and it thus ſpontaneouſly ſeparates into whey, and curd; but this does not happen in emulſions. If long boiled over the fire, it loſes its more fluid part, and condenſes into a butyraceous and cheeſy maſs; but not into an uniform one that will cut like the dry'd ſerum of the blood, or white of egg. It has a pleaſant taſte, and no unpleaſant ſmell; it is extremely mild, and of a middle nature between the blood and the chyle; and hence proves different according to the aliment, and the creature that prepares it. Having laid down theſe particulars, we come now to examine it.

PROCESS LXXXIX.

That recent cow's milk is neither acid nor alcaline, remarkably ſaline nor ſpirituous; by means of the forty-fifth, forty-ſixth, forty-ſeventh, forty-eighth, and forty-ninth proceſſes.

'NEITHER the ſmell, nor taſte, nor the dropping of new milk into 'the eye, manifeſt any acid, alcaline, or ſaline matter to be con-

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‘ tained therein. If the milk be heated, and ſucceſſively mixed with pure ‘ volatile and fixed alcali, there ariſes no effervefcence, that ſhews any aci- ‘ dity; but the milk grows ſomewhat thick and turbid. To other parcels ‘ of the ſame milk add the acid ſpirit of vinegar, of nitre, of ſalt, and of ‘ vitriol, and theſe make no effervefcence, ſo as to manifeſt the milk to be ‘ alcaline, but thicken and coagulate it. But upon mixing milk whereto ‘ oil of tartar *per deliquium* was poured, along with ſome oil of vitriol, there ‘ immediately ariſes a violent effervefcence, and much greater than if the ‘ ſame quantity of alcali was added to pure oil of vitriol. If new milk be ‘ diſtilled in a glaſs alembic, with a fire of about a hundred and ſixty degrees, ‘ there comes over an aqueous liquor, without any ſigns of an inflammable ‘ ſpirit; nor does this liquor give any chemical ſign of being either acid, or ‘ alcaline, upon mixing with either acid, or alcaline ſalts. It alſo appears ‘ not to contain any trace of a ſaline matter; being inodorous, and perfectly ‘ inſipid, and cauſing no pain if dropped into the eye. There remains ‘ behind a yellow, thick, unctuous maſs, of a ſweet and grateful taſte, which ‘ maſs gives not the leaſt appearance of containing any thing acid, alcaline, ‘ or ſaline, upon all the trials made to diſcover it.

The uſe.

This is the true nature of milk, thus variouſly examined; whence we here find no ſigns of a perfect fermentation, either of the acetous, or vinous kind; nor of putrefaction, which produces an alcaline ſalt, or fetid oil; and this tho' a great part of the animal juices be mixed with the vegetable matter of the milk. Whence we muſt form a very different notion of the action performed in the making of chyle and milk, than chemiſts uſually ſuppoſe and deliver. And as cattle are milked twice a day, this whole operation muſt be performed in the body in the ſpace of twelve hours; and if detained longer, it begins to degenerate and corrupt. This experiment was made with cow's milk, becauſe they feed wholly upon graſs, hay, and water. There is, ſometimes, a difference found in women's milk, from the difference of the aliment; but, when freſh, there is little difference to be obſerved. Some have ſuppoſed that there was here a latent acid, tho' it did not appear upon the preceding experiment; but if acids are denominated with reſpect to our ſenſes, or their ſenſible effects, there is no acid contained in recent milk.

PROCESS XC.

Freſh cow's milk coagulates with acids, even in a boiling heat.

‘ LET new milk boil in ſeveral different veſſels, with the addition of a ‘ little water to prevent its growing too thick in the boiling; pour ‘ into one of them a little vinegar, and one part of the milk will preſently ‘ coagulate, and leave the other fluid. Into a ſecond pour the ſpirit of ‘ nitre; to a third, ſpirit of ſalt; and to a fourth, the oil of vitriol; and ‘ the ſame effect immediately enſues: nor can this coagulation be prevented

' by a heat of two hundred and twelve degrees. The ſame coagulation is ' made with any other acid, as the juice of ſorrel, barberries, citron, currans, verjuice, tamarinds, and tartar; ſo that the thing, which of itſelf ' was ſo liquid, as to paſs thro' the fineſt arteries, now has one part ſeparated into a groſs, curdy matter, and another into a much thinner than ' the milk itſelf, called whey. If the curd be ſtrongly preſſed betwixt a ' thick linen, it makes cheeſe; which conſiſts of the cream of the milk and ' the curd. This cheeſe, with age, becomes ſharp and biting, not acid, ' but rather ſomewhat alcaline, of a particular ſmell, and ſo penetrating a ' taſte, as often to inflame the mouth. But when the milk is firſt deprived ' of its cream, and afterwards coagulated with acids or with rennet, the ' cheeſe, thence made, proves very dry and hard like horn; and when applied to the fire grows tough, ſcorches, fries, burns and ſmells perfectly ' like horn. This is a ſtrange change of ſo fluid a matter as milk, but is, ' perhaps, the origin of all the ſolids in the body.'

The uſe.

The nature of milk, thus diſcovered, is the ſame in the receptacles of the breaſts, where it is lodged, and therefore may be there coagulated by a like ſaline, or acid matter; at which time the thin ſerum comes out at the nipples, and the thick curd remains in the veſſels, ſo as there to produce hardneſs, ſwellings, inflammation, ſuppuration, ſcirrhoſities and cancers; and, perhaps, the ſame may happen in the chylous glands of the meſentery. But in all theſe coagulations with acids, the milk retains its white colour; and hence appears the reaſon why weak conſtitutions make a white chyle and milk, but with difficulty convert it into a red blood; whence ſuch perſons abound with acid, are troubled with acid eruptions, their ſweat and ſmell being alſo acid, and the whole body pale; which particulars being conſidered, may lead phyſicians into a due underſtanding of many diſeaſes.

PROCESS XCI.

Recent cow's milk coagulates, turns yellow, and red, by boiling over the fire with fixed alcali.

' DILUTE new cow's milk with a little water, boil it in a clean veſſel, and by degrees drop oil of tartar *per deliquium* into it; it will ' thus begin to turn yellow, the more ſo as more alcali is added, and the ' boiling the longer continued, ſo as to paſs from a faint yellow into a red ' colour. At the ſame time it coagulates more and more, and ſeparates into ' curdy maſſes, tho' not ſo large and firm, nor ſo eaſily hardening, as thoſe ' produced by acids. At length by boiling the whole long enough, it becomes a thick, red, coagulated maſs.

The uſe.

Milk, therefore, which, mixed with acid, or its own rennet, retains its white colour, even in the heat, immediately turns yellow, with alcalies, in a ſtrong

a ſtrong heat, and if the heat be ſufficiently intenſe, almoſt red. When a woman that gives ſuck becomes highly feveriſh, the milk in the breaſt is corrupted, and in this caſe it becomes yellow, ſaline, thin and ſanious; the coagulated thick part, remaining in the breaſt, now grows ſomewhat fetid, and is abhorred and loathed by the child. When therefore the milk coagulates in the body, and grows yellow under a fever, the phyſician muſt not ſuppoſe it coagulated by an acid, but by too much heat, and rather by an alcaline tendency: and, perhaps, phyſicians find the milk thus coagulated by a fever, a hundred times for one where it is coagulated by an acid. And in the laſt contagion among the cows, whilſt their meat remained in the ſtomach, and was neither diſcharged upwards by ruminating, nor expelled downwards, and therefore truly putrefied with the violent degree of heat, ſo that the ſtomach was almoſt ſcorched with heat, as we explained the thing under the eighty-eighth proceſs, then the milk grew ſharp, yellow, ſomewhat fetid, and thin in the dug, and in this form was either milked out, or dropped ſpontaneouſly. And thus, if when milk is coagulated either by chemical acids, or by rennet, and heated, and alcali be put thereto, we ſhall find that falſe which is every where aſſerted, *viz.* that alcalies ſhould diſſolve the coagulation, and recover the former fluidity. And hence we may underſtand how milk will long remain white in the weakeſt and coldeſt conſtitutions, and not be brought to the natural redneſs of blood. And hence ſuch perſons are continually pale, and their blood thin, pale, and watery; and upon the removal of the diſorder the whiteneſs vaniſhes, and the red colour returns. So when the vital faculties are but moderately ſtrong, they are only able to convert ſome part of the milk into blood, but not to perfect the whole; in this caſe there ariſes a ſomewhat pale, yellowiſh, or greeniſh colour, whence the green-ſickneſs in virgins: but where the vital faculties are robuſt and ſtrong, ſo that they briſkly circulate and heat the milk, the white colour is ſoon ſubdued and turned into an highly red one; whence the blood ſhall often be ſo intenſely red, as to appear almoſt black. Laſtly, it is manifeſt that the white colour of the milk may remain in the body that abounds with acids; but if alcalies preſide therein, it will gradually acquire, firſt the colour of bile, afterwards grow more intenſely yellow, and tend to redneſs. Doctor *Lower* has ſhewn that the white colour ceaſes, twelve hours after feeding.

PROCESS XCII.

Urine is neither acid, nor alcaline, but fetid.

'TAKE the urine of a man in health, made twelve hours after eating ' or drinking, which muſt therefore have remained ſo long in the ' body, and have circulated almoſt the ſame time therein, and have been ' mixed with nearly all the juices in all the veſſels, by means of the vital ' powers. It is therefore an aqueous lixivium, that has waſhed away, and ' brought off with it, whatever would diſſolve in water, and run thro' the ' fine urinary veſſels of the kidneys: particularly it contains the ſpirituous

'ſaline

'saline and saponaceous matters of the blood; and when thus long retained 'and digested, it acquires the true nature of the body, as being wrought 'upon by the vital powers for twelve hours successively; at which time the 'milk has lost its own nature in the body, and now begins to be converted 'into the serum of the blood. And for this reason such urine should be 'chose as is well concocted, and discharged at twelve hours distance from 'feeding, the thinner and more crude being come away before. Such urine, 'therefore, may always be collected without the body, and yet retain and 'perfectly exhibit the nature of the animal juices, and their principles. This 'urine is not acid, because it neither tastes nor smells sour, nor gives a red 'colour by mixing with those juices that turn red with acid; and lastly, 'because, if heated and mixed with oil of tartar *per deliquium*, it affords not 'the least sign of effervescence. And if another part thereof be heated and 'mixed with the alcaline spirit of sal-ammoniac, it manifests no sign of 'effervescence; nay, what seems stranger, the urine of a man who drank a 'large quantity of *Rhenish* wine, which is considerably sour, and also of sour 'beer, used much vinegar in his sauce, and eat largely of fruit, did not 'afford the least signs of acid, upon any experiment, twelve hours after eat-'ing. So likewise the urine discharged by young female persons of weak 'constitutions, that use little more than acid vegetables and milk for their 'meat and drink, manifests no acid twelve hours after meals; the natural 'powers therefore have in this time conquered that tendency which vege-'tables had to acidity, or else the acid that was in them. *Helmont*, there-'fore, justly said that acids were enemies to the veins; but his followers 'hence unjustly forbid the use of acids in diet and medicine, as if they were 'poisonous, supposing them prejudicial to the first passages. These expe-'riments will be allowed by chemists; but it may, perhaps, move them to 'hear that there is no manner of alcali contained in this urine, and yet the 'thing is certain; for if to separate parcels of this heated urine, there be 'successively poured vinegar, lemon-juice, spirit of nitre, spirit of salt, and 'oil of vitriol, no effervescence ensues; but these acids, mixed with warm 'urine, discharged at the distance of twelve hours after eating, unite there-'with, as water unites with water, without bubbles, and without hissing. 'Such urine also does not turn the juices of herbs to a green colour, as all 'alcaline salts do.'

The use.

Hence we may collect, that the powers of the body change acids, so that they remain no longer the same, and prevent things disposed to acidity from becoming acid; and that in health, alcaline salts are never produced, but only such as are neutral. And this I have observed in the urine of persons in high fevers, and inflammatory diseases, where the vital actions being increased, rendered the urine flame-coloured, fetid, sharp, and little in quantity: for even such urine, examined by the methods above-mentioned, gave no signs of its being alcaline: whence I was led to consider whether in a perfect stoppage of urine, where this liquor is long detained, heated, and agitated in the body, it would not become alcaline. And it happened

happened that an eminent perſon in years, falling into this diſtemper, which proved fatal to him, had no diſcharge of urine for five days, but on the ſixth, ſuddenly made a few ounces, that was red, turbid, and of a fetid ſmell; but he had hence no relief, and made not a drop afterwards, but died. This urine I directly carried home with me, and preſently examined by the known chemical methods, none of which ſhewed it to be alcaline; whence I underſtood that urine could not become alcaline in the ſpace of a hundred and twenty hours, tho' agitated by the heat of the body, and the action of circulation: for in the patient above-mentioned, the bladder contained no urine; and I have never found any of the humours in health to be alcaline, tho' they may become ſo from other cauſes: nor did I ever find them alcaline in the moſt putrid diſeaſes, whether acute or chronical. I remember once an ancient corn-merchant had a large ſtone in his bladder: but being not a fit ſubject to be cut for it, his urine would often, when he was in exquiſite torture, ſmell alcaline; and as he had frequent ſtoppages, a ſkilful ſurgeon was obliged often to put back the ſtone from the neck of the bladder, with a catheter, towards the bottom; but being once abſent, the patient continued in pain, without making water for ſeveral hours; but the operator returning and performing his uſual office, the urine came out ſo ſharp, alcaline and putrefied, and with ſuch a peculiar ſtench of digeſted urine, that the ſurgeon inadvertently drawing the vapour thereof into his lungs, was thereby diſordered for ſome days. Whence I conceive, not having any opportunity of examining this urine, becauſe it was ſpilt, that, being attracted into the pores of the ſpongy ſtone, and lodging therein, it was thus digeſted by the heat, and ſo, perhaps, acquired a true alcaline acrimony: however this were, it is certain that the urine contains no native alcaline ſalt, and, conſequently, no other humour of the body; becauſe the urine holds more ſalts than any other animal liquor; and becauſe the ſalts of the urine are more acrimonious, and eaſier rendered alcaline, than of any other liquor in the body. Whence thoſe artiſts are greatly deceived, who ſo loudly cry out againſt the natural, volatile, oily, alcaline ſalts in the body. This is an error introduced into medicine, by an imprudent cultivation of chemiſtry, which the more prudent cultivation thereof muſt correct: the fetid ſmell of urine in health is therefore entirely owing to the attenuating, putrid, and volatilized oil, which is inſeparable from it; and not to a volatile, alcaline ſalt. Its bitter, nauſeous, and ſaline taſte, is owing to the compound ſalt of the urine, and to the oil, as alſo to the ſea-ſalt which urine generally contains.

PROCESS XCIII.

Freſh urine, diſtilled in a cloſe veſſel, affords a fetid, nauſeous water, neither alcaline, acid, ſaline, nor vinous.

'TAKE well concocted human urine, diſcharged in health, and diſtil
' it in a glaſs body, with a gentle fire of a hundred and fifty degrees,
' uniformly kept up, till only a twentieth part remains behind. There
' will come over a limpid water; the urine in the mean time gradually
' changes

'changes from its natural ſtraw colour, to red; and the more of this pellucid water comes over, the deeper that red colour appears; and at length the remainder becomes of an almoſt black red, very thick, turbid, opake, frothy, and tenacious. The firſt limpid part has a particular nauſeous ſmell, but not that of a volatile alcali; but what ſeems ſtrange, tho' it be often diſtilled over again, yet it always retains this nauſeous odour, and even tho' it ſhould long ſtand in the open air. This corrupt odour, therefore, is inſeparable, and intimately mixed with the liquor, ſo as not to be deſtroyed even by the addition of an acid. It ſeems to reſemble nothing more than that diſagreeable exhalation, which ariſes from wounds in the *abdomen*, or the carcaſs of a man freſh opened after a violent death. The nauſeous taſte of that water, tho' ſomewhat putrid, is not alcaline, or any way ſaline, howſoever it be diſtilled. Again, in the diſtillation thereof, there appear no veins upon the glaſs ſtill-head, as in the diſtillation of vinous ſpirits; and if the water that firſt comes over be a ſecond time diſtilled, neither thus will the leaſt quantity of any ſuch ſpirit appear; and tho' ever ſo carefully rectified, it has, ſo often as I have examined it, never took flame, but always quenched fire. Even the urine of ſuch men as are great drinkers of ſtrong liquors, ſuch as wines and diſtilled ſpirits, never affords any thing inflammable. When this firſt diſtilled liquor of the urine is mixed with acids, it never gives any ſigns of effervescence, nor changes juices green, as alcalies always do, nor conſiderably precipitates the ſolutions made with acids: and by no manner of rectification will it afford a manifeſt ſalt, nor ever change acids into a compound, neutral ſalt. Conſequently it is no alcaline liquor: nor does it manifeſt the leaſt ſigns of acidity upon any kind of experiments; as the addition of fixed and volatile alcalies, the various juices that turn red with acids, &c. Whence we ſeem to have proved our point.

The uſe.

We may learn many momentous particulars in medicine from this ſlight experiment. Thus, (1.) we ſee, the lighteſt, thinneſt, and moſt volatile part of the healthy juices is nearly elementary water, excepting that there is inſeparably joined therewith, that other equally light, thin, volatile, fetid, and ſeemingly corrupted matter, not proceeding from a ſaline principle, but rather from an oily one, and yet no way vinous or inflammable. (2.) Whence there is no fermentation in the juices, nor no production of inflammable ſpirit, which is eaſily ſeparated from water; whereas this fetid part can by no means be ſeparated from its water. (3.) Conſequently there is no inflammable ſpirit in the vital juices of the body. (4.) Oil, by the vital powers of the body, is rendered much more volatile than any ſalt in the body, contrary to what is generally believed. This peculiar, fetid, oily matter is ſcarce otherwiſe found, than in the matter of perſpiration, the ſweat, and the vapour which naturally reſides in the cavities of the body. Vinous ſpirits, when drank, do not go to the urinary paſſages, and may, therefore, riſe to the head, diſturb the brain, the common ſenſory, and the origin of the nerves; and hence, perhaps, they ſo wonderfully affect the actions of

of the *cerebrum* and *cerebellum*. And hence, perhaps, it is, that they ſo eaſily exhale from the body, poſſibly at the ſurface of the ſkin. Our preſent proceſs alſo ſhews that there is no volatile ſalt in the body, capable of riſing with this degree of heat, whatever chemiſts or phyſicians may think to the contrary; and that there is no volatile alcali, whether ſimple, or oily, nor any volatile acid in the body; ſo that the modern phyſic muſt be greatly corrected in theſe particulars. The fetid ſmell of the urine always increaſes and decreaſes, as the vital powers increaſe or decreaſe, in an healthy body; and the more the body is exerciſed by labour and motion, the more this fetid ſmell is always increaſed, and *vice verſa*. If any thing in the animal juices is to be called ſpirit, on account of its acrimony, volatility, lightneſs, and penetrating virtue, it is neither vinous, nor ſaline, but really ariſes from an oil corrupted, or turned to ſuch a putrefaction, as that deſcribed under the eighty-eighth proceſs.

PROCESS XCIV.

The remains of the recent urine, after the preceding proceſs, are neither acid, nor alcaline, nor truly ſaponaceous, but ſaline and fetid.

‘IF the groſs remainder, after the preceding diſtillation, be mixed with ‘any kind of acid or alcali, it affords no ſign of efferveſcence, ſo as ‘to appear either acid or alcaline; nor can it be manifeſted by any other ‘experiment. It is indeed highly ſharp, of a very ſaline taſte, and a little ‘bitteriſh, but not alcaline, nor has it an alcaline odour, but ſmells fetid ‘almoſt as before. If uſed by fullers and wool-ſcourers, it neither cleanſes ‘nor deterges, and therefore has no ſaponaceous virtue, which it excel‘lently acquires by putrefying. In this whole inſpiſſation there appears no ‘ſigns, either of chyle or milk. Nor have I, with the utmoſt attention, ‘ever diſcovered the leaſt of that coagulation, which the lymph and ſerum ‘of the blood always run into by heat. And however treated, it manifeſts ‘nothing of a cheeſy nature, but conſtantly the more it is inſpiſſated ‘by the fire, the ſharper and deeper coloured it becomes; and thus, by ‘various degrees, it increaſes and changes in colour, thickneſs, and acri‘mony, the longer the inſpiſſation is continued, ſo as to run thro' all that ‘diverſity uſually obſerved in the urine, under acute and chronical diſtem‘pers, as *Bellini* has excellently obſerved. In acute diſeaſes, the hotter the ‘fever, and the more it diſſipates the moiſt parts, the redder, the ſharper, ‘and the thicker the urine becomes.’

The uſe.

There is, therefore, naturally no fixed or volatile alcali in an healthy body, nor any fixed or volatile acid in the natural juices, whilſt they remain ſound; but this ſalt is of a particular nature, which we ſhall hereafter exa-

mine, and much lefs volatile than water, as not rifing even with a boiling heat. It is furprifing, that no nutrimental matter fhould ever be contained in this urine; for there is no chyle, milk, curd, ferum, or *lympha* therein, which coagulate by fire; but phyficians juftly acknowledge thefe as the original matter of nutrition. Nothing nutrimental, therefore, is difcharged the body along with the urine. Thus all the parts of the chyle, milk, blood, or the humours thence prepared, that become fharp, corrupted, fubtile, unfit for nutrition, hurtful to the body, and, having performed their office, are at length feparated by the vital powers, and by means of the kidneys difcharged the body. Urine, therefore, exhibits the humours highly changed by the powers of the body, even fo far as never afterwards to prove healthful thereto; and therefore the fmall quantity, the fharpnefs, colour, and thicknefs of the urine, afford many juft informations to the phyfician, as indicating the neceffity of water, demonftrating the condition and ftatè of the humours, the remedies required in difeafes, and what things are chiefly deftructive to the body, by diffolving the texture of the blood, and how pernicious a great fluidity is.

PROCESS XCV.

Recent urine, infpiffated to a fortieth part, and diftilled with fand, affords an alcaline fpirit, an alcaline, volatile falt, a very fetid oil, and faline fæces.

'IF the diftillation of the urine be continued, till of forty pounds thereof, firft taken, there remains but one; or if the like recent urine be fuffered to exhale in a low, capacious, cylindrical, open veffel, with an almoft boiling heat, till only a fortieth part remains, there will be found at the bottom a grofs, thick, blackifh, fharp matter, which being mixed with thrice its weight of clean fand, and then diftilled in a retort, in a fand-heat, by gentle degrees at firft, and often examining the liquors that come over, by removing the receiver, a limpid water will firft rife, as in the preceding procefs; and when the matter begins to be almoft dry, another limpid liquor will come over, of a fharp, fiery, alcaline nature. Continue the operation fo long as this rifes, and keep it feparate, then clofely lute on a receiver, and urge the matter by degrees of fire, upon which white clouds will long continue to rife, and unctuous veins appear, whilft a fomewhat oily, yellow liquor, together with a white, folid, and alcaline falt will rife. At laft, with the utmoft violence of fire, there comes over a yellow or gold-coloured oil, and when this ceafes, a faline, feculent matter remains at the bottom. The firft water is fcarce alcaline, fharp, faline, or any way oily, but like the water of the preceding procefs: the fecond liquor has a fharp and manifeft faline odour, it proves pungent and fiery upon the tongue, and has a perfect alcaline tafte; it makes a violent effervefcence with all acids, and when faturated with any

'acid,

'acid, concretes therewith into a compound, neutral, half-volatile ſalt, like 'ſal-ammoniac, but of a determinate nature, according to that of the acid. 'This ſalt, therefore, is truly alcaline and volatile, like that produced in 'the eighty-eighth proceſs. All this appears more in the third unctuous li-'quor, which is much more intenſely alcaline, tho' oily; and hence is uſu-'ally called alcaline ſpirit, as conſiſting of water, ſalt, and oil mixed to-'gether. The whole ſalt is always alcaline, but rendered very ungrateful 'by the fetid oil adhering thereto. The oil, which comes over at the 'ſame time, and afterwards is highly fetid, and infects every thing with 'its odour, ſo as to be intolerable, and not only retains the ſmell of 'urine, but is ſomewhat ſtercoraceous. The remaining fæces being calcined 'in an open fire, and then elixated with water, afford a true ſea-ſalt, if the 'perſon have uſed that ſalt in his food.'

The uſe.

Hence it appears that the ſalt of urine, tho' not alcaline of itſelf, may be rendered ſo by a certain degree of heat, and that this urinous ſalt is not ammoniacal, becauſe ſal-ammoniac, tho' volatile with a certain degree of heat, yet when ſublimed thereby, never becomes alcaline, but remains compounded, how often ſoever it is ſublimed; whereas the ſalt of urine, tho' likewiſe of a half-fixed nature, and becoming volatile with a certain degree of heat, at the ſame time alſo becomes alcaline, and no longer retains the nature of a compound ſalt. It therefore approaches to the nature of alcaline ſalt, and ſal-ammoniac, tho' itſelf be neither of them. Hence alſo we ſee, that the ſalt, ſaline ſpirit, and firſt oil, are almoſt equally volatile in a ſound ſtate: and that this unctuous ſpirit conſiſts of water, oil, and ſalt, into which it may be commodiouſly reſolved. And hence alſo we underſtand, how by the natural powers, the mild, white, indolent, inodorous, and unctuous matter of the aliment, chyle, milk, fat, and marrow, may turn into another that is ſharp, yellow, inflammatory, thin, and fetid; whence alſo the fetid ſmell of the urine uſually proceeds. Again, we hence learn, that there is no fixed alcali in the animal juices; for I never could find a grain thereof in the largeſt quantity of the urine thus treated. And laſtly, that ſea-ſalt may enter the blood, mix therewith, thence paſs into the urinary veſſels, and yet remain unchanged, ſo as to act thro' moſt of the veſſels of the body, without ſuffering an alteration by their re-action. All which particulars being conſidered, our preſent experiment, which is owing to *Helmont*, will be found of infinite uſe in medicine.

PROCESS XCVI.

Recent inſpiſſated urine, diſtilled with fixed alcali.

'FRESH urine being inſpiſſated as before, pour thereon an equal 'quantity of the oil of tartar *per deliquium*, or the ſolution of pot-aſhes, 'and there will inſtantly ariſe a ſharp, alcaline, volatile vapour, ſuch as uſu-

'ally proceeds from well putrefied urine, when it grows warm. If the 'mixture be now immediately diſtilled in a glaſs alembic, with a gen-'tle fire, there comes over a limpid liquor, running in veins, which 'proves ſharp, highly alcaline, and more volatile than water, and in every 'reſpect reſembling true and ſtrong alcali. And when inſtead of the oil of 'tartar, the dry ſalt of tartar be uſed, a dry alcaline ſalt often riſes firſt in 'this diſtillation. And when the former alcaline liquor is again diſtilled 'in a tall body, with a gentle fire, the part that firſt riſes is ſaline, white, 'and alcaline; the oil remains at the bottom along with the fixed alcali 'added, as if it was more fixed thereby. Laſtly, when all is become dry, 'if the fire be ſtrongly kept up, there likewiſe comes over a fetid, yellow 'oil after the ſalt.'

The uſe.

This experiment ſhews the nature of the animal, urinous ſalts to be ſuch, that a fixed, alcaline ſalt can inſtantly change them, like the violent action of the fire, in the preceeding proceſs. And hence we learn, that fixed, alcaline ſalts, being mixed with the juices of the body, will preſently render them ſharp, alcaline, extremely moveable, and more volatile than the water and ſpirit of the body; communicate a fiery, corroſive nature to the ſpirits, and immediately give them a tendency to putrefaction. If the ſalt and ſaline ſpirit, thus produced, be ſeveral times diſtilled over again with a gentle fire, they at length become as purely alcaline as thoſe prepared from hartſhorn, or other coſtly ſubſtances: when mixed with acids, they make a violent effervеſcence, eſpecially if ſhook together; and by this means are ſo mortified and changed, as to loſe their ſharpneſs, and all their alcaline or fiery nature; being thus alſo ſo fixed, as not to prove volatile with the heat of an healthy body. They loſe the proper virtue of acting like volatile alcalies, eſpecially that of almoſt mortally diſſolving and attenuating the juices of the body. And what is more to our purpoſe, phyſicians may hence underſtand the ſurpriſingly changeable nature of the ſalts of the body; how variouſly they may alter from their native diſpoſition; and the proper effects of each alteration; and alſo learn the remedies and degree of correction which each requires: all which were known to the ancients from experience. Thus in fevers, attended with an increaſed heat and motion, *Hippocrates* allowed only of things tending to an acid nature, or actually acid, to be uſed as food, drink, or medicines: and hence we ſee, that fixed alcalies are deſtructive in the body, as often as attended with heat, motion, a fetid ſmell, a flame colour, or ſmall quantity of the urine, or the juices are too much diſſolved; ſo that in ſuch caſes to exhibit theſe ſalts, is highly dangerous, eſpecially in the plague.

PROCESS

PROCESS XCVII.

Recent urine, especially when inspissated, affords a fiery spirit that is not alcaline, upon the addition of quick-lime.

'IF quick-lime be thrown into recent urine, there instantly exhales a spontaneous vapour, which strikes the nostrils with an extremely pungent and fiery sensation; and if it be now directly and gently distilled in very close vessels, it affords a limpid water of an intolerable fiery odour, like the former, but much more sharp and volatile. And if, when the urine is first inspissated to a quarter part, an equal quantity of quick-lime be mixed with the remainder, the odour is much stronger, and the spirit, obtained by distillation, not to be equalled by any other for its sharp, fiery, subtile, and volatile nature. After all this spirit is separated by distillation, and the remaining mass afterwards treated by the same operation, it will never afford a solid salt, as in the preceding process; but always a very fluid, saline liquor: and whatever acid is mixed therewith, it causes no effervescence, tho' the fiery virtue and volatility are greatly diminished thereby. There is caution required in this process: for as soon as the quick-lime touches the urine, or the inspissated matter thereof, it excites a great ebullition, and a violent heat, and at the same instant the most sharp and volatile spirit hitherto known arises; and, being agitated with the violent heat, it is put into a furious motion, so that being inadvertently received into the lungs, it may instantly prove highly dangerous, and occasion an instantaneous inflammation in the tender vessels of the lungs, and directly communicate it to the blood circulating thro' them: for if this spirit be held to the external warm skin, it immediately makes the part gangrenate, and mortify; but, perhaps, the whole thickness, between the circulating blood in the lungs and the air contained in the vesicles thereof, is not the thousandth part of an inch: but this urinous spirit, prepared with quick-lime, suddenly exhales its sharp part in the open air, and leaves a water behind.'

The use.

Hence we may learn the action of quick-lime upon the saline urinous juices of the body; for when assisted by heat, and the vital motion, it presently generates these fiery spirits, that prove destructive to the tender, pappy mass of the brain and nerves; and the hotter, or the more agitated the body, or the more it is affected with inflammatory disorders, the more destructive the use hereof. But when the body abound with acid, water, or phlegm, the prudent application thereof may be sometimes of service. We must also consider, that the lixivium of quick-lime has a great force in correcting, and extricating the muriatic, fixed salts in the blood, and fitting them to be easily discharged; whence it becomes an extraordinary remedy in that kind of scurvy, which chiefly proceeds from the above-mentioned causes: but in that kind which proceeds from putrefaction, and consists in a sharp oil and

salt,

ſalt, it proves highly prejudicial. Whence, perhaps, we may in ſome meaſure reconcile the experiments of ſome eminent phyſicians in *France*, which ſhew the lixivium of quick-lime to be pernicious in that country; whereas in *Germany* it appears a very advantageous medicine. But all this holds truer of the quick-lime prepared from ſtone, than of that from ſhells: the particulars hence ariſing ſeem to be theſe; (1.) The violent corroſion, which happens in a live body, upon the application of quick-lime, proceeds more from thoſe fiery ſaline ſpirits, which the lime produces from the ſalt that was not ſharp before, than from the corroſive body of the lime itſelf. (2.) And hence it may be of uſe in diſeaſes proceeding from acid, aqueous, auſtere, viſcous, mucous, and phlegmy cauſes, where motion and ſtimulation are wanting. (3.) On the contrary, it proves hurtful in acute diſtempers proceeding from alcaline, bilious, ſaline, putrid, acrimonious, and heating cauſes; where the body is dry, and ſtrongly agitated by motion. (4.) The mild ſalts of the body may inſtantaneouſly become extremely ſharp and poiſonous, by the bare admixture of a thing not ſharp itſelf. (5.) That an exceeding ſharp matter may be produced from healthy juices, which is neither a ſalt, ſpirit, nor oil; for this liquor cannot, by any art that I know of, be made to appear in the ſolid form of a ſalt, and can be only obtained inviſible by means of water. (6.) Theſe ſpirits, therefore, that do not appear to be alcaline by any experiments made with acids, are much ſharper than any alcali; ſo that there is not any known thing that yields a ſharper and more odorous vapour. Whence alſo it appears, how ſuddenly a very different taſte and ſmell may ariſe from the ſalt of the body, which is almoſt inodorous.

PROCESS XCVIII.

The native ſalt of urine.

'TAKE very freſh urine, diſcharged twelve hours after eating, by a 'man in health, and immediately, by a gentle fire of two hundred 'degrees, evaporate it in a clean veſſel, till it acquires the conſiſtence of 'cream. Then ſtrain the liquor hot thro' a flannel bag, that the viſcous 'oil may be ſomewhat kept back and ſeparated, which the more exactly it 'is done, the better. Set a large quantity of this inſpiſſated liquor, in a tall, 'cylindrical, glaſs veſſel, tied over with paper, in a cool place, for a year; 'during which time, a ſaline, ſolid, hard, brown, and ſomewhat tranſparent 'maſs will concrete to the bottom thereof; and a thick, black, unctuous 'liquor float above it, as ſeparated and excluded from the ſalt. Pour off 'the liquor, and putting the ſaline maſs into another veſſel, add very cold 'water thereto, and ſhake it a little therein, to cleanſe it from its oily 'foulneſs; which is eaſily done, becauſe the matter does not readily diſſolve 'in cold water. Let this ſaline maſs be preſerved under the title of the 'native ſalt of urine. If this ſalt be diſſolved in water, and ſeveral times 'ſtrained, till the ſolution becomes limpid, and then exhaled to a pellicule in a clean glaſs, and ſet to reſt in a cool place, it ſhoots into ſaline

'glebes,

'glebes, of its own peculiar kind, very different from any other ſalt, tho' 'ſomewhat reſembling the cryſtals of ſugar, in figure and hardneſs. They 'are not fetid, or alcaline, but extremely volatile : and this is the purified 'ſalt of urine.'

The uſe.

This experiment excellently ſhews phyſicians the nature of thoſe ſalts, which in an healthy body are very ſharp, and greatly inclining to an alcaline nature, yet not really alcaline; and therefore require to be quickly diſcharged by the vital powers, to which they however owe their origin. And hence phyſicians may know that the other ſalts, contained in the other juices, are much leſs ſharp or alcaline. Theſe ſalts are generated in the human body alone, from the meat, drink, and ſea-ſalt taken in and changed. There is ſea-ſalt contained herein, but not alone. It is a ſaponaceous ſalt, but not very unctuous. It is highly diuretic, if drank diluted with water; and ſudorific with a proper regimen. It has ſuch extraordinary effects upon metals, that ſome have thence promiſed themſelves wonders. All the fat matter, which remains upon ſtraining, and cleanſing the inſpiſſated urine, is, when dried by a gentle fire, excellent for the producing of phoſphorus; for which end it may be preſerved. The experiment alſo ſhews that the ſalts remaining in the urine, thus inſpiſſated, will not putrefy, or grow alcaline, ſo as to become volatile, and eaſily fly off, tho' they are otherwiſe ſo eaſily changed. It ſhould be conſidered what ſhare this ſalt has in producing the ſtone of the bladder or kidneys.

PROCESS XCIX

Milk, by digeſtion, affords cream, and turns ſour.

'SET new cow's milk in a capacious, cylindrical, glaſs-veſſel, in a cool 'place, barely covered with paper; there will ſoon be gathered on the 'top a white, thick, unctuous, mild liquor, called cream, which is neither 'acid, nor alcaline: let this be carefully ſeparated and kept apart in an-'other clean glaſs. In a ſhort ſpace, afterwards, more of the ſame, but 'leſs in quantity, riſes, which is again to be taken off, and added to the 'former; and continue thus till no more cream riſes. The remaining liquor 'is thin, ſomewhat tranſparent, and bluiſh. The cream is an excellent balſam 'for external and internal uſe, agreeable to the body, and allays all acrimo-'ny, ſo as to prove highly ſerviceable in caſes of the pthiſick, ſtone, or gout, 'and alſo ſerviceable, when applied to wounds and ulcers. The ſkimm'd 'milk is an incomparable remedy for ſharp diſeaſes, in fat and bilious con-'ſtitutions, as containing no oil. Hence it appears to have a great relation 'with vegetable emulſions, made according to the twenty-firſt proceſs, only 'differing on account of the juices it is mixed with, and the different de-'gree of heat in the body. If the milk ſtand in a clear, pure, warm air, 'no way infected with fetid or putrid exhalations, or in ſixty degrees of 'heat, or more, it ſoon begins to turn ſour, and afterwards becomes per-

'fectly

'fectly acid, ſo as at length the whole milk, together with its cream, mani-'feſt a conſiderable acidity by their ſmell, taſte, acrimony, and other ſigns. 'In like manner the cream, carefully ſeparated from the milk, alſo turns 'ſour in an high degree; and then alſo affords an excellent balſam for ex-'ternal and internal uſe in hot and bilious diſorders. And all this happens 'ſooner in the heat of ſummer, than in the cold, and the more when the 'cow feeds upon graſs, than upon hay; and the more when the creature 'is leſs exerciſed, than after having undergone violent motion. When the 'milk is afforded by an animal heated above meaſure, whether by labour, 'or otherwiſe, or was fed with animal food, or alcaleſcent vegetables, &c. 'or came from creatures under a burning fever, or a putrid diſorder, the 'milk, treated in the manner above-mentioned, will be found of a ſome-'what fetid and urinous odour, of a yellowiſh colour, thin, and not of ſo 'ſweet, but of a ſaline ungrateful taſte; and thus it will not turn ſour by 'digeſtion, but acquire the unpleaſant odour of rancid cheeſe, and tend 'almoſt to an alcaline nature; whence ſuch milk in nurſes is abominated 'by the infants.

The uſe.

This experiment is of that kind, which, tho' ſimple, teaches many uſeful particulars, both to the chemiſt and phyſician. It ſhews that milk, more than any other juice of the body, abounds with oil; which here more eaſily ſeparates from the aqueous part, than in any other; whence milk holds but little ſalt, and that not wrought in, and united with the oil, and therefore greatly differs from a ſoap, which is compounded of ſalt and oil united together: whence oil is ſlowly ſubdued, or thoroughly mixed with the other juices of the body. And hence it is that oil ſo often and ſo eaſily ſeparates from the reſt, and collects into the cells and cavities of the bones, deſtined for its reception; from whence again it may and uſually is diſſolved by heat and motion, ſo as to return into the veins, mix with a ſharp ſaline matter, and at length be diſcharged the body under the form of ſtrong-ſcented, fat, yellow ſweat, or ſharp, high-coloured, putrid urine. It is manifeſt alſo, that this oil of the vegetable milk long retains its diſpoſition to acidity in the body, and there ſometimes is converted into acid. And all milky aliment tending to acidity, whether it proceed from animal, or vegetable ſubſtances, does for ſome hours retain this diſpoſition in the body, and operate upon it; but if the vital powers, great heat, the want of acidity, and the corruption of the air, act upon this cream or milk, it may then grow bitter, rancid, or alcaline, and forſake its acid nature, as we have formerly obſerved of tartar. We muſt therefore uſe great care, and cautiouſly diſtinguiſh in pronouncing upon the nature of juices in animals; for the milk depoſited in the breaſts may, by a fever, be changed to a rancid acrimony, and produce ſtrange diſorders, as we daily find. And the ſame thing may happen in the milk mixed with the blood. Certainly the oil of milk may grow acid, bitter, rancid, and at length putrefied; its cheeſy part alſo may grow rancid, putrefied, highly acrimonious, and ſomewhat alcaline: its ſerous part uſually grows chiefly acid, but ſeldom undergoes any other change.

PROCESS

PROCESS C.

Urine, by digeſtion, turn alcaline, and changes its colour, odour, taſte, and virtues.

'IF ſuch urine as was deſcribed under the ninety-ſecond proceſs, be kept 'in an open veſſel of glaſs, earth, wood, or metal, in an air of thirty- 'three degrees of warmth, it begins to ſmell fœtid, putrefy, and change its 'ſtraw-colour for a duſky brown; depoſiting groſs fæces, and thus in a few 'days acquiring an alcaline lixivious nature, and at the ſame time ſtriking 'a ſtony cruſt on all the ſides of the veſſel. The hotter the air is, the ſtronger 'and quicker this change of the urine is made; whence in the ſummer- 'time, eſpecially when the weather is hot, all this happens in a greater de- 'gree. To diſcover how far this changeable nature would reach, I fil- 'led a bottle with natural recent urine, and corking it cloſe, ſet it in a 'moderately warm place; and, after three months, I found it changed, in 'this cloſe veſſel, as is deſcribed in the preceding caſe. And herein the 'change principally conſiſts; the recent urine of a man in health is of a 'ſtraw-colour, but when thoroughly digeſted, of a colour betwixt brown 'and blackiſh; and from the degree of a ſtraw-colour, it daily proceeds 'thro' ſucceſſive changes, till at length it ends in a deep brown; and the 'more it is putrefied, the darker the colour. And the ſame thing is obſerved 'by phyſicians in the urine of perſons under a fever; the ſtate of the juices 'being learnt from the colour of the water. Recent urine ſmells ungrateful, 'tho' not alcaline; but digeſted urine has a manifeſtly fetid, volatile, alca- 'line odour, very different from the other. Recent urine is of a bitter, ſa- 'line taſte; but digeſted urine putrid, ſharp, alcaline, and perfectly lixi- 'vious. Recent urine affords no ſigns of containing an alcali; but digeſted 'urine makes an ebullition, and a violent effervefcence, upon mixing with 'any acid, and in every other tryal, manifeſts a true alcaline nature. Re- 'cent urine has no ſaponaceous ſcouring virtue; but digeſted, putrefied urine 'is uſed by ſcourers and dyers, as a ſharp lie, that cleanſes foul wool, ſilk, '*&c.* after the manner of fixed alcalies: and as theſe changes happen, with 'a ſmall degree of heat in a cloſe veſſel, which every one may be eaſily ſa- 'tisfied of by tryal, it is in vain for chemiſts to deny this property in urine.

The uſe.

We are here to conſider, that there is ſeparated from the body, by the urinary paſſages, a water containing ſalts and oils, approaching to a ſtate of putrefaction; nor do we find, in all the body, another fluid that is ſo eaſily changed by ſuch a digeſtion in cloſe veſſels. Urine, therefore, which is de-ſtined for excretion, cleanſes the blood from theſe noxious, putrid matters; and, therefore, if retained thro' any diſtemper, it produces mortal effects, as being ſoon rendered ſharper by the heat of the body, and thence preſently intolerable to the finer veſſels, and diſſolving to the humours by a perni-cious relaxation. And as it thus eaſily and ſuddenly acquires theſe new pro-

perties in a clofe veffel, with a moderate heat, we are fhewn that the body neither produces vinegar, nor inflammable fpirit from what it takes in, and confequently does not act by fermentation, but introduces the true change of a putrefied fubftance, and therefore in its effect approaches nearer to the nature of the eighty-eighth procefs: for if bare ftagnation can occafion this change of the urine, how greatly muft it be difpofed to a true putrefaction? And hence we fee, how great neceffity there is of water, acids, and faline matters in thofe perfons who live in hot climates, and accuftom themfelves to daily labour and exercife; for by meats, drinks, and fauces of this kind, too great a tendency to putrefaction is prevented. Hence alfo the daily neceffity of a mild, fomewhat acid, and a new chyle, for fheathing the acrimony produced in the blood. Hence alfo it appears, that in twenty-four hours, the neceffary utility and fervice of this new chyle vanifhes; and that frefh affiftance is likewife required from the fame means. In burning fevers, therefore, tart, acid, and mild aliments, like chyle, are extremely neceffary; great abftinence being in thefe cafes highly prejudicial. And hence it is that barley ptifans, with vinegar and honey, are here fo ferviceable, as *Hippocrates* prudently inculcates, in his incomparable book concerning the diet in acute difeafes. The phyfician alfo, upon examining the urine, by means of thefe experiments, may learn many ufeful particulars, with regard to the change of the oil and falt thereof; and perceive that a true ftone may be generated from the urine of a man in health, even by reft, and whilft the urine putrefies, or grows alcaline; and therefore that attenuation, alcalies, and putrefaction, do not prevent the origin of the ftone, fince it may be generated, and not diffolved even in putrefied urine. Hence, therefore, as tartar is generated in the beft wine, fo is the ftone generated, and not diffolved, in the urine elaborated by the vital powers: and, therefore, volatile alcaline falts are in vain given to prevent the generation of the ftone. The following experiment I have feen with horror. Upon filling a clean glafs bottle, with the recent urine of a healthy perfon, and fetting it by for fome time, then pouring out the putrefied liquor for diftillation, there was a ftony cruft all round the infide of the glafs; without wafhing this off, I filled it with frefh urine, fet it by as before, and afterwards emptied it; and by repeating this feveral times, I at length found the whole furface of the glafs perfectly crufted over with the matter of the ftone. This production of a ftony matter feems very deftructive, tho' neceffary to the body. It may, perhaps, feem ftrange, why the body fhould not therefore putrefy by its own vital heat and motion, fince it fo foon putrefies the wholfomeft juices; and fince dead carcafes, expofed in air heated to eighty degrees, in a few hours putrefy, refolve away, and fly off into the air; leaving only the bones behind: but chemiftry fupplies us with this anfwer, that fuch a putrefaction is prevented by the meat, drink, fauces, air, and fometimes the medicines ufed, which refift putrefaction; otherwife, in burning fevers, the whole ftructure of the body would prefently be diffolved by putrefaction.

PROCESS

PROCESS CI.

Digested urine affords, by distillation, an alcaline spirit, a fetid oil, a volatile, alcaline salt, phosphorus, and sea-salt.

'TAKE urine, digested according to the foregoing process, distil it 'and with a gentle fire in a low glass body; there first arise veins of 'liquor running in the form of unctuous spirits. The receiver being chang-'ed, and the fire a little increased, there follow dewy drops, resembling 'water; and this water may be accurately separated till the matter remains 'almost dry; which, again being urged by degrees, and at length by a 'strong fire, will afford a yellow and very fetid oil, along with something 'saline; black fæces will remain behind, which, when burnt in an open 'fire, become a white calx, that with water resolves into sea-salt, and a 'fixed, insipid, subtile earth. The first water is fetid, sharp, fiery, per-'fectly alcaline, and makes a violent effervescence with acids. If this be 'distilled in a tall vessel, by a gentle fire, it affords a white, solid, truly 'alcaline salt; and leaves a water of an ungrateful smell and taste behind. 'When the water that came over second is long distilled in a tall vessel, 'with a gentle fire, it affords somewhat of the former spirit; which be-'ing carefully separated, and the remaining water distilled in a clean vessel, 'it affords a liquor which *Helmont* recommends, in his treatise on the stone, 'for an admirable lithontriptic. There here appears no fixed alcaline salt, 'but a true sea-salt, if the person used much thereof: but when I desire to 'obtain a large quantity of the salt, I usually proceed thus.

'I put a hundred weight of urine into a large low vessel that widens up-'wards, and inspissate by boiling, with care to prevent the unctuous mat-'ter from boiling over; and being left, till the whole acquires the consis-'tence of honey, I put a large quantity of this into an open cylindrical 'glass, and expose it for some months in a warm room, so that it may be 'well putrefied; I afterwards put the mass into an iron pot, to the mouth 'whereof a large earthen still-head may be commodiously fitted, and close-'ly luted; the head has a long pipe, to which I apply a capacious re-'ceiver, then raise the fire by degrees, upon which an incredible quantity of 'a white alcaline salt arises, next a yellow oil that fouls the former salt, 'and with it another salt somewhat more fixed. I urge the fire till 'the pot begins to grow red-hot, at which time the oil and the last 'salt come over; then suffering the iron pot to cool a little, whilst the 'fixed matter continues sufficiently hot, I take away the receiver, and put 'up all that was raised into glass bottles, and stop them close. This after-'wards resolves into spirit, salt, and oil as the former. If what now re-'mains at the bottom, be mixed with twice or thrice its weight of wood-'coal, and then put into little coated retorts, and urged with the utmost 'violence of fire for sixteen hours, into receivers filled with water, and so 'placed as to bury the necks of the retorts under water, little blue masses 'of matter will at length come over, and fall to the bottom of the re-'ceivers, whence they are collected so as to be gathered together under

 'water,

' water, in a ſmall veſſel; which being ſet over the fire ſo as to be very ' hot, the matter of the phoſphorus melts without diſſolving in the hot ' water, and runs into one maſs like melted wax, and may be afterwards ' preſerved for twenty years, or more, under water, without loſing its ' virtue (*a*). But if another part be taken of the maſs, as it remains in the ' pot, and calcined in an open fire, to a white calx; this calx, when put into ' water, communicates a ſaline matter thereto, and which, when reduced, ' proves to be true ſea-ſalt, that remained thus unchanged thro' all the di- ' geſtions of the body, and even after ſuch a long continued putrefaction ' and diſtillation. That it is a true ſea-ſalt appears manifeſt from the taſte, ' but more particularly, becauſe, when mixed with *aqua fortis*, it diſſolves ' gold: ſo that there is no fixed alcaline ſalt found even in this urine; but ' whatever it contains of ſaline is either of the volatile kind, or ſea-ſalt.'

The uſe.

This is the true analyſis of urine after putrefaction, where it affords all the ſame matters as that which is diſtilled freſh, tho' with a leſs heat, and in an inverted order. Putrefaction renders the ſalts more volatile than water, and makes thoſe alcaline which were not alcaline before; it renders the oil ſharper, more fetid, and more volatile, yet produces no inflammable ſpirit, no fixed or volatile acid, nor any fixed alcali. Yet theſe two ſalts appear differently volatile, the firſt whereof eaſily riſes and ſeparates almoſt pure; the other with more difficulty, ſlower, and mixed with a copious oil, not eaſily to be ſeparated from it, and requires a large, and in part the ſtrongeſt fire to raiſe it. I once urged the prepared fæces of urine, with the moſt violent fire, for the making of phoſphorus, and was ſurpriſed to find how long this ſaline matter continued to come over, after having ſo long ſuffered the violence of a former fire; but this ſalt was ſtrangely denſe, yellow, fetid, and fixed to the ſides of the retort. All acids, therefore, are here changed into a neutral, ſaline ſubſtance, by the vital powers; yet this neutral ſalt becomes truly alcaline by putrefaction, and more volatile than any hitherto known, even than alcohol itſelf. This putrefaction volatilizes all the ſaline matters of animals and vegetables, but can neither convert ſea-ſalt into an alcali, or render it volatile. Some eminent chemiſts have ſaid, that an acid might, by the force of fire, be drawn from the fæces of urine, remaining after its diſtillation: and I have found this true, where common ſalt was largely uſed by the perſon, and not changed, as was above obſerved, but remaining plentifully in the fæces: for being thus mixed in a large proportion of earth, the extreme violence of the fire drives over the acid of the ſalt, which has thus been haſtily taken for the acid of the natural juices: yet it muſt be acknowledged that phoſphorus ſpontaneouſly reſolves into an acid by the air, not greatly differing from the oil, or acid ſpirits of vitriol or ſulphur; whence it makes a kind of compound body with

(*a*) See *Boyle* Abr. vol. III. p. 208. The Act. *Lipſ.* 1683. p. 457. *Homberg*, Memoir. Math. & Phyſ. 1692. p. 74, and 80. *Nieuwentyd*, p. 520. *Hoffman*, Diſſert. Phyſ. Chem. p. 336.

quick-

quickſilver (*a*): but whence this acid ſhould proceed, I am at a loſs to know, as alſo of what nature it is. Certainly, it ſuits neither with animals or vegetables; perhaps, alum might be added in the preparation: for thus it may be obtained to advantage; and the acid ſpirit of alum is very like that of vitriol. On the other hand, it has appeared by experiments, that fowls feeding upon vegetables inclined to acidity, and drinking nothing but water, whilſt they were cooped up, and being afterwards calcined with an open fire, together with all their excrement, afforded fæces that contained nothing either of acid, or of an alcaline nature. If a ſpirit, highly ſaturated with volatile alcaline ſalt, be highly rectified, it becomes limpid; but if afterwards long kept, it changes brown, and generally depoſites ſomething terreſtrial to the bottom and ſides of the veſſel. Let it be examined whether this is not that volatile earth, which riſes with the firſt ſpirit of putrefied urine, that tarniſhes the glaſs ſo as not to be got off again but by the other ſubſequent ſpirit, which, tho' ſcarcely ſaline, ſpontaneouſly diſſolves it; of which *Helmont* treats ſo largely in his noble book of the ſtone. This deſerves to be thought of and tried, as being an eaſy thing that has its uſe. Certainly alcalies rather generate the ſtone; but if the ſecond liquor, which is not alcaline, diſſolves the ſtone, then urine will contain both the matter of the ſtone, and its ſolvent. Sea-ſalt, therefore, does not generate the ſtone, but rather reſolves it, and prevents it, as hindering, by its ſaltneſs, the tendency of the humours to an alcaline nature and putrefaction. Whence *Helmont* conceives, that vinegar, ſea-ſalt, and ſulphur, were the great anti-peſtilential remedies of *Hippocrates*, being uſed along with fumigated wine: whence the adepts declare, that nature has lodged abſolute perfection in ſalt. It does not however commodiouſly diſſolve the ſtone formed in the urine, or the concretions of the gout.

PROCESS CII.

The origin of ſal-ammoniac.

'THE preſent ſal-ammoniac comes to us in merchant-ſhips, chiefly 'from *Egypt*. It is almoſt tranſparent in the middle, having long 'parallel ſhoots: it is black at the bottom, and formed into cakes, which 'are flat at the top, ſpherical below, and conſiderably denſe and large; the 'middle part, when examined pure, has ſcarce any odour; it has the taſte 'of ſea-ſalt, but is much more penetrating: in the open air it ſoon ſpon'taneouſly runs wholly into a clear, ſaline ſolution; it is a ſalt like that I 'obtained from ſoot, as mentioned under the eighty-ſixth proceſs; ſo that 'the two would ſcarce be diſtinguiſhed. The preſent ſal-ammoniac is made 'of ten parts of the inſpiſſated urine of animals, chiefly of camels, which 'drink little, two parts of ſea-ſalt, and one part of the beſt wood-ſoot; all 'which they boil in water, ſtrain and dry, then ſublime in proper veſſels;

(*a*) See *Homberg*, *Memoir. de l'Acad.* 1706, p. 340. & *Mem. de Math.* & *Phyſic.* 1692. p. 80.

'again diffolve, purify and coagulate; and in both thefe ways this falt is 'obtained (*a*).'

The ufe.

The origin of fal-ammoniac is wonderful. The ancient *cyrenaical* or ammoniacal falt was made from the urine of camels, plentifully difcharged in the fand, dried by the fun, and afterwards fublimed in the fandy deferts of *Lybia*, where camels are chiefly ufed. Such a falt Mr. *Tournefort* prefented to *Pomet*, which differs greatly from our common falt (*b*); as feeming wholly animal. There is another fort, faid to be at this time produced and collected in hot countries, near burning mountains, which feems to proceed from foot (*c*); and from foot I have myfelf made it. But the compound kind confifts of an animal, vegetable, and mineral fubftance united together; for urine of itfelf putrefies into an alcaline falt; but fea-falt keeps this under, and curbs and turns it into fal-ammoniac: and the foot of burnt vegetables yields the fame falt. It is no lefs wonderful in its virtue than its origin. If diffolved in water, ftrained, and infpiffated to a pellicule, it affords white fubtile cryftals like dew; which being dried, and carefully preferved from all moifture, and afterwards mixed with water, cool it more in the inftant of folution, than can be done by any other known means. It admirably preferves all animal fubftances from putrefaction; and its folution penetrates to the innermoft parts thereof. It is chiefly opening, attenuating, diffolving, refolving, fternutatory, diaphoretic, fudorific, diuretic, and prefervative.

PROCESS CIII.

Sal-ammoniac is neither acid nor alcaline.

'DISSOLVE pure fal-ammoniac in thrice its weight of fair water, 'filter the folution, heat it to a hundred degrees in a clean glafs, and 'pour thereto, fucceffively, vinegar, fpirit of nitre, and fpirit of fea-falt; 'there thus arifes no fign of effervefcence, nor is the liquor fo much as 'troubled; whence it appears that this falt is not alcaline upon thefe trials. 'Indeed, when oil of vitriol is poured to it, there arifes a certain fume and 'motion; but this is owing to another property of the falt, which will be 'more commodioufly explained hereafter, under the hundred and fixth, and 'hundred and feventh, but particularly the hundred and forty-third procefs; 'whilft the oil of vitriol lays hold of the alcali of this falt, and renders its 'acid fpirit, which is the fpirit of fea-falt, volatile. To another quantity 'of the fame folution add fixed alcali, and this alfo caufes no effervefcence; 'but there immediately rifes a very pungent, volatile odour. Hence it ap'pears, that fal-ammoniac is neither acid nor alcaline.'

(*a*) See *Olaus Worm*, Muf. p. 20. and *Cæfius de Foffilibus*.
(*b*) See *Pomet* of drugs, and compare *Pliny* 31. 7. and *Diofcorid.*
(*c*) *Hift. de l'Acad.* 1705.

The

The use.

Sal-ammoniac, therefore, agrees with the natural ſalt of the body, which neither makes an effervescence with acids nor alcalies; but when mixed with fixed alcali, immediately ſends out a volatile part, with a very pungent odour: and that it does not not act either in the body, or elſewhere, by an acid or alcaline virtue, but by that of common ſalt rendered more penetrating, appears from all its effects, eſpecially from hence, that when ſal-ammoniac is mixed with ſpirit of nitre, or *aqua fortis*, it immediately gives them the power of diſſolving gold, or turns them into *aqua regia*, which nothing but common ſalt can do; and therefore in this ſenſe ſal-ammoniac is a half volatile ſea-ſalt.

PROCESS CIV.

Sal-ammoniac ſublimed into flowers.

'REDUCE ſal-ammoniac to fine powder, dry it thoroughly, put a 'pound thereof into an almoſt cylindrical *Haſſian* body, fit on a very 'capacious head, lute the juncture with equal parts of clay and ſand wrought 'together; ſet it in a ſand-furnace, ſo that the pipe of the alembic-head 'may ſtoop a little, in order to diſcharge the water, that may happen at 'firſt to come over into the receiver, then bury the body in ſand almoſt 'up to the lower rim of the head; give a fire firſt of a hundred and fifty 'degrees, till all the moiſture is raiſed, and come into the receiver; which 'being now changed, raiſe the fire ſo long by degrees, till the glaſs-head 'begins to be darkened with a kind of ſnowy matter, and continue the 'ſame degree of heat for eight or ten hours without ſlackening; now let all 'cool, take away the ſand, and carefully remove the body with its head, 'without ſhaking, for fear the ſalt, raiſed into the head, ſhould fall out. 'Then place them both horizontally upon a table, and with a knife take 'off the luting; and whilſt both the body and head remain in this poſition, 'gently wipe away the duſt, ſand, and remains of the luting; the head, 'now ſeparated, will be found full of a light, ſnow-white ſalt, ſublimed by 'the operation. Take all the ſalt out, and put it into a dry, hot, wide-'mouth'd glaſs. There will alſo be found towards the upper part of the 'earthen body, a white, thick, denſe and compact cruſt of the ſame ſalt, 'that here remains fixed, without riſing into the head; this, being ſeparated 'with a knife, is to be put into another glaſs apart: then gently invert the 'body upon a clean paper, and there will fall out a large quantity of the 'former ſnowy flowers, made to fall back by the motion of the veſſels. If 'theſe are perfectly pure, they may be added to the former. At the bot-'tom of the body there remain a ſmall quantity of black, ſaline, feculent 'matter, of no great uſe, which may be got out by ſhaking the veſſel; 'it is bitter, black, and foul. The former part, being kept ſeparate, is called 'the flowers of ſal-ammoniac, or the white eagle of the philoſophers, that 'carries *Ganimede* up to *Jove*: the other ſalt, which ſtuck to the other part

'of the body, is a fublimed fal-ammoniac. If the flowers, or fublimed falt, 'be diffolved in water, they produce coldnefs, as we above obferved. If 'any acids be mixed with the heated folution, no effervefcence arifes, ex- 'cept with oil of vitriol, as was obferved of the falt in the preceding pro- 'cefs. It makes no effervefcence with fixed alcali, yet immediately raifes 'the fame vapour as was before defcribed; but when the fublimation of 'the fal-ammoniac is often repeated, it gradually begins to rife with more 'difficulty, and at length becomes almoft fixed, tho' it ftill retains its for- 'mer nature.'

The ufe.

This falt is of the nature of fea-falt, and half volatile; for tho' it will not afcend with the heat of boiling water, yet it is not fo fixed as fea-falt. When thus purified, it lofes the tranfparency, which is in fome meafure found in common fal-ammoniac. This falt does not grow alcaline by fublimation; in which refpect it differs from the falt of urine, as ftill remaining what it was, tho' more purified. It has this wonderful property, that by thus rifing dry in a clofe veffel, it carries up with it almoft all animal, vegetable, and mineral fubftances, and ftrangely fubtilizes them in the fublimation; whence it has been called the peftle of the chemifts; as thofe bodies could fcarce be fo fubtilized by any other means. But if often fublimed with fal-ammoniac, they are thus at length fixed therewith: and in this method excellent medicines are often prepared; as we fee by the example of *Paracelfus* in colcothar well wafhed in water, then ground with fulphur, and fublimed with this falt.

PROCESS CV.

Sal-ammoniac, with quick-lime, affords a fiery fpirit, like that of the ninety-feventh procefs.

'1. PUT well dried flowers of fal-ammoniac into a glafs-body made hot, 'pour thereon an equal quantity of quick-lime, fuddenly reduced 'to fine powder, in a hot and dry iron mortar, fo that the flowers of fal- 'ammoniac may be well covered therewith. Immediately clap on a dry 'alembic-head to prevent all evaporation; for at the inftant thefe two bo- 'dies touch each other, tho' they were before at reft and inodorous, there 'arifes, perhaps, the moft pungent and violent vapour hitherto known. In 'thefe two refpects it certainly far exceeds the fpirit obtained, by the fame 'means, from urine, in the ninety-feventh procefs. After the head, there- 'fore, is well luted on, diftil, with a fand-heat, into a proper receiver; a 'very fmall quantity of liquor will thus be obtained, but it is the moft vo- 'latile and fharp of all that are known, yet not alcaline. And now if the 'fire be urged, the fal-ammoniac does not fublime, but remains fixed in 'with the quick-lime; and if put into a crucible, and melted with a very 'ftrong fire, it ftill remains fixed, and when cooled and well dried, it thus 'affords a light like phofphorus, if broke in the dark (*a*).

(*a*) See *Hiftor. Academ. Royal. du Hamel.* p. 305, 306, 307, 408.

'2. Reduce

'2. Reduce pure ſal-ammoniac to powder, diſſolve it in thrice its quantity of fair water; then put into a large glaſs-body, a little heated, thrice the quantity of quick-lime, in reſpect of the ſal-ammoniac; pour the ſolution thereto, inſtantly clap on the head, directly lute with a thick luting of linſeed-meal, and apply a very capacious receiver, joined with the ſame luting; a heat and violent ebullition will now ſuddenly begin to riſe, yielding a ſpirit ſo forcible as to burſt the veſſels, if the luting was not to give way, thro' which the ſpirit flows like blaſts of wind, and diffuſes an odour all round; at the ſame time there ſuddenly comes over a large quantity of liquor into the receiver. As ſoon as the ſpontaneous heat of the mixture ceaſes, lute the junctures ſtronger, apply a little fire, and gradually diſtil to dryneſs. Let the ſpirit that comes over be directly put up in a glaſs to be cloſe-ſtopped, and kept under the title of the ſpirit of ſal-ammoniac with quick-lime.

'3. There now remains at the bottom a ſtrange and new kind of body, which when dried at a ſtrong fire, appears ſomewhat glaſſy; but it gradually ſwells in the air, tho' it does not run like ſal-ammoniac, but reſolves into ſandy grains, as the excellent Mr. *Homberg* has obſerved (*a*).'

The uſe.

We have hence a new agreement betwixt the proper ſalt of the human body, and ſal-ammoniac; here is a liquor produced from dry bodies; a highly odorous matter from what was inodorous, and affecting the organs more ſtrongly than any other known thing. We here ſee ſpirits produced, which are extremely moveable, as it were ſpontaneouſly, in the higheſt degree of cold; and theſe ſpirits, tho' exceeding ſharp, and almoſt as acrimonious as fire, yet are not alcaline. This ſpirit, however, floating thro' the air, and meeting with the volatile ſpirit of nitre, affords white fumes. We have here a new ſpecies of phoſphorus, and an inſtance of ſal-ammoniac rendered in ſome meaſure fixed.

PROCESS CVI.

Sal-ammoniac, diſtilled with fixed alcali, affords an alcaline ſpirit, and a volatile alcaline ſalt.

'1. PUT ten ounces of the dry flowers of ſal-ammoniac into a glaſs retort, add thereto three ounces of dry ſalt of tartar, reduced to powder, ſhake and mix them well together; there immediately ariſes an extremely ſharp and alcaline vapour; therefore, inſtantly apply a large glaſs receiver, and ſublime in a ſand-furnace by degrees, giving at length a violent fire. A white, pure, volatile, alcaline ſalt will thus riſe, which ſoon ſpontaneouſly flies away into the open air, from the veſſel it is contained in, and nearly thro' all ſtoppers, except thoſe of glaſs: it makes a violent efferveſcence with all acids, and concretes with them into a neutral ſalt, according to the nature of the acid: it can ſcarce be employed, or con-

(*a*) *Hiſt. Academ. Roy. du* Hamel. p. 305, 306, 307.

'fined, on account of its extreme volatility; and is difficult to take out of 'the receiver in this folid form. A fixed falt remains at the bottom of the 'retort, which cannot be fublimed by the ftrongeft fire.

'2. Or to the fame flowers add three ounces of the falt of tartar, and 'nine ounces of water; mix them, and diftil into a receiver exactly luted on, 'with various degrees of fire. A moift, flatulent vapour will prefently rife, 'which directly congeals on the fides of the receiver into a folid falt, and 'continues to do this every moment, till the chief part of this falt being come 'over, it begins to refolve by the rifing of a lefs volatile and more aqueous 'liquor. Therefore, change the receiver, and urge the fire till the falt re- 'mains dry at the bottom, then by well fhaking the former receiver, mix 'the falt with the liquor, till it breaks, and becomes almoft diffolved; then 'pour it into a clean glafs, the mouth whereof is exactly fitted with a glafs- 'ftopper. A falt will fall to the bottom, and a fluid liquor float above, 'which is a true and ftrong volatile, alcaline fpirit; but when no alcaline 'falt remains in a folid form under the liquor, the fpirit is not rich, but 'aqueous, and unfit for many experiments. At the bottom of the retort 'there remains a fixed falt, exactly like that in the preceding procefs.'

The ufe.

The fal-ammoniac, in this operation, is by its own nature, and by means of fire, divided into two very different faline parts, immediately upon touching fixed alcali. The firft of thefe parts we fhall here confider, and the fecond in the following procefs. The firft, therefore, conftitutes an extremely fharp, alcaline, fiery, volatile, pure falt, as any that can poffibly be obtained by art, and at the fame time the moft fimple; fo as to be held for the ftandard of volatile alcali, under which the other kinds may be reduced, and accordingly diftinguifhed. The true alcaline fpirit of fal-ammoniac is therefore a water, impregnated with as much pure alcaline falt, as it can diffolve, and with this likewife all the other alcaline volatile fpirits may be compared; and, indeed, all other volatile alcaline falts and fpirits are never fo pure and genuine as thefe, but conftantly infected by fome oil, which occafions them to act very differently; but in this property alfo fal-ammoniac agrees with the falt of urine, as appears by the ninety-fixth procefs; for the prefent falt and fpirit inftantly make a violent effervefcence with all acids. If the glafs, containing either this falt or fpirit, ftand open near another filled with the ftrong acid fpirit of nitre, there immediately arifes a confiderable effervefcence in the air, proceeding from the volatile acid and alcali meeting therein. If this falt be applied to the warm fkin, and kept clofe to it by a plaifter, to prevent its exhaling, it prefently burns the part with intolerable pain, and with a violent inflammation turns it to a black gangrene, fo that there is fcarce a more fudden poifon. Whence it fhould feem imprudent to direct the ufe of thefe falts or fpirits in the way of fmelling-bottles, for fear of corroding and inflaming the olfactory nerves, the membrane that lines the noftrils, and the tender veficles of the lungs. Both this falt and fpirit are tendered ftill more fiery by fubliming them afrefh from pure, dry, fixed alcali.

PROCESS

PROCESS CVII.

The fixed ſalt remaining in the preceding proceſs, examined.

'TO the ſalt remaining at the bottom of the retort, in the preceding 'proceſs, pour as much warm rain water as may wholly diſſolve it, 'then filter the liquor, inſpiſſate it, and reduce it to cryſtals, till almoſt the 'whole quantity is thus prepared: by this means there will be obtained a 'ſalt, which in its taſte, its cubical cryſtals, and power of diſſolving, re-'ſembles common ſalt; and if put into a covered crucible, and decrepitated, 'and calcined for ſome time, then diſſolved and coagulated, a pure ſalt will 'be obtained, which taken in the quantity of a drachm, two hours before 'the fit of an intermittent is expected, (the body at the ſame time being 'kept warm) often cures the fever. Whence it is called the febrifuge ſalt 'of *Sylvius*.'

The uſe.

This is the other ſaline and fixed part of the preceding proceſs, ariſing from a mixture of fixed alcali and ſal-ammoniac, agitated by the fire; it is neither acid, nor alcaline, but a compound neutral ſalt, tho' not ammoniacal, but fixed. Sal-ammoniac is made from the volatile alcali of urine, the volatile vegetable alcali of ſoot, and of ſea-ſalt; ſo that here the fixed alcali, being ſtrongly attractive of acid, draws to itſelf the acid of the ſea-ſalt, and ſeparates it from the volatile, animal alcali or that of ſoot. Whence the acid of the ſalt returns with the fixed alcali into a fixed ſea-ſalt; and the volatile alcali of the ſal-ammoniac, now ſet free from its fixed ſalt, becomes perfectly volatile, and when collected together, affords a pure alcali; and when ſaturated with the acid ſpirit of ſea-ſalt, it makes regenerated ſal-ammoniac, as will appear in the hundred and forty-ſeventh proceſs.

PROCESS CVIII.

A ſaline ſpirit produced by mixing the ſtrongeſt volatile alcaline ſalt, or pure alcaline ſpirit, with the ſtrongeſt ſpirit of vinegar.

'TO a quantity of pure volatile, alcaline ſalt, or ſpirit, contained in a 'large glaſs, pour at ſeveral times a proportion of the ſtrongeſt ſpi-'rit of vinegar, ſhake and mix them well together, till no more effer-'veſcence ariſes; warm the whole, then add more of the ſalt or ſpirit, and 'if now no farther ebullition appears, the point of ſaturation is obtained: 'and if the operation be rightly performed, the liquor prepared by this 'mixture of a volatile alcali, and acid, will be ſaline, tho' not eaſily redu-'cible to a ſolid ſalt, but affording a very penetrating medicine.'

The uſe.

This liquor is not only the moſt penetrating of all thoſe applied to the body, but has its effect without any corroſion, and at the ſame time, by its preſervative ſaline virtue, admirably prevents the putrefaction of the juices; ſo that, perhaps, a more noble aperitive, attenuating, diaphoretic, diuretic, and ſudorific remedy is not known. When externally applied, in the way of fomentation, it is highly diſcutient and reſolvent, and eminently ſerviceable in all diſeaſes of the eyes, where any darkneſs appears in the *cornea*, or aqueous humour of the eye, being properly applied as a collyrium. Perhaps, this is the moſt ſubtile of all compound neutral ſalts, and may not improperly be called ammoniac.

PROCESS CIX.

The white of new laid eggs ſhewn to be neither acid, alcaline, nor ſpirituous.

'PUT the whites of ſeveral eggs, carefully ſeparated from the yolks, 'ſhells, and films, into different glaſſes, and to each of them drop 'different acids; ſhake and mix them; no ſign of ebullition will appear. 'Set theſe glaſſes aſide, and in two others put two freſh portions of white, 'and intimately mix with one a fixed alcaline ſalt; and with the other, a 'volatile alcaline ſalt; they will neither afford any ſign of efferveſcence: 'but if half an ounce of the white of egg be contained in a tall cylindrical 'veſſel, along with two drachms of the ſpirit of nitre; and in another veſ-'ſel, half an ounce of white of egg, with four drachms of oil of tartar *per* '*deliquium*, both of them heated to ninety-two degrees; and the white with 'the alcali be once poured into that with the acid, there riſes a violent 'ebullition and rarefaction, tho' almoſt without changing colour; and when 'the efferveſcence is over, they immediately ſhrink into the narrow ſpace 'they poſſeſſed before. But if the recent white of egg be diſtilled with a 'fire of a hundred degrees, it affords only an inſipid water, that contains 'no inflammable ſpirit. If the white be applied to the naked eye or a naked 'nerve, it excites not the leaſt ſenſation of pain; it has ſcarce any ſmell, or 'taſte, and to the touch appears viſcous, and no way piercing.'

The uſe.

Hence there is no alcali, or acid, or a mixture of the two contained in recent white of eggs; and tho' it appears ſo unactive a thing, yet it is a truly animal liquor, that with ninety-three degrees of heat, in the ſpace of one and twenty days, gives growth to the chick in the egg, from a little ſpeck, ſcarce weighing the hundredth part of a grain, into a perfect animal body weighing an ounce, or more. Hence we know that this liquor is different from all others; as by the requiſite cauſes there may be produced from it fibres, membranes, veſſels, *viſcera*, muſcles, bones, cartilages, tendons, ligaments, beaks, claws, feathers, and all the juices contained in the veſſels;

veſſels; and yet this fluid is mild, ſluggiſh, without acid, without alcali, without ſpirit, and without any requiſite for making an effervefcence. Indeed, if there was the leaſt effervefcence therein, the egg would directly burſt. Such, therefore, is the matter of the whole ſtructure of the chick; which ſhews us from what a viſcous and inactive ſubſtance, all the ſolid and fluid parts of its body is formed: yet this very matter is rendered unfit for producing a chick with a greater degree of heat. It can ſcarce endure a hundred degrees to advantage; and with a much leſs heat it would never produce a chick; for leſs than forty degrees will not ſuffice for that purpoſe; but with a middle heat, directed betwixt eighty and a hundred degrees, the wonderful viſcoſity of this ſubſtance is attenuated, ſo as in great meaſure to exhale thro' the ſhell, and its two membranes; whilſt the yolk, the ſpecks, and nutrimental bag remain behind: for the yolk is the placenta of the chick, and not conſumed in the nouriſhment thereof. But *Malpighi* has ſhewn that this white is not of the ſame fluid nature throughout, as the ſerum of the blood is, whilſt flowing thro' the veſſels, but a compound ſtructure of numerous membranous bags, filled and extended with their proper liquor, almoſt in the ſame manner as we ſee in the vitrious humour of the eye: and hence ſeem to proceed thoſe waves concentrical to the little nutrimental bag, by means whereof the nutritious juice is gradually attenuated, and ſtrained into the *amnion* of the chick.

PROCESS CX.

The white of egg hardened into a ſolid maſs, by the heat of boiling water.

'1. THE white of an entire egg, being kept in a warmth of eighty 'degrees, ſoon loſes its tenacity and thickneſs, and becomes ſo 'ſubtile, as to perſpire at the obtuſe end of the egg, thro' the ſkins there 'placed, ſo as to depreſs and ſeparate them from the hollow part of the 'ſhell towards the yolk, and thus leave a conſiderable cavity. The re'maining part of the white is diſſolved, becomes thin and ichorous, and no 'longer hardens with the heat of boiling water, but becomes fetid, putrid, 'highly ſharp, and deſtructive to the vital ſtructure of the chick. 2. The 'recent white, being put into water, heated to a hundred and fifty degrees, 'loſes its tranſparency, becomes white, opake, and hardens into a denſe 'maſs, that may be cut with the knife; and if a little of this white be 'dropped into boiling water, contained in a glaſs urinal, it is preſently 'coagulated, amidſt the motion of the boiling water. In like manner, a 'whole egg is alſo coagulated. Whence it appears, that this coagulation does 'not happen thro' a loſs of the fluid parts diſſipated by the heat, but by 'the true action of the fire applied in ſuch a degree; becauſe this happens 'even in the midſt of water; and if ſome of the white were to be mixed in 'with cold water; it would immediately come together, and ſeparate from 'the water, upon boiling. 3. When the white is boiled hard in a whole 'egg, then taken from the ſhell, and ſeparated from the ſkins, the ſpeck, the

'yolk,

'yolk, and the nutrimental bag, and put into a glazed difh, it gradually 'begins, as it were, to fweat, and to refolve into a fubtile fluid, which 'appears aqueous, yet is a very penetrating menftruum that excellently 'diffolves myrrh, and other bodies hard of folution.

The ufe.

This experiment fhews us the heat required in that matter whereof all the parts of an animal may foon be formed; and we fee that it diffolves with one certain degree of heat, but coagulates with a greater: and again, that a lefs diffolves it after coagulation. The whole, therefore, is owing to a determined degree of heat, without which nothing can here proceed well. And it will again appear, under the hundred and twelfth procefs, that a greater heat than of two hundred and twenty-four degrees will diffolve and attenuate what was coagulated by a heat of two hundred and twelve degrees. Hence, therefore, we are admonifhed to pronounce with caution, concerning the diffolving and coagulating power of heat, with refpect to the nutrimental juices of animal bodies; or as to that heat, which may thin them, putrefy, infpiffate, or refolve them into their parts.

PROCESS CXI.

The white of eggs examined with alcohol.

'PUT the yolk of an egg into a glafs, and gently pour thereto a quantity of alcohol, fo that it may run down the fides of the veffel to 'come at the white; this fhould purpofely be done to fhew that the furface thereof immediately coagulates upon touching the alcohol, whilft 'the lower part ftill remains fluid and tranfparent. Then the two being 'gently fhook together, it will appear, that wherever the alcohol touches 'the white, the white will there be coagulated; and when they are entirely 'mixed together, the whole white will thus be concreted. If the alcohol 'be previoufly heated, the effect will the fooner be obtained, as alfo the 'more brifkly they are mixed together; for heat and motion increafe this 'coagulation.'

The ufe.

Hence again, it appears, that pure, inflammable, vegetable fpirits will immediately coagulate the nutrimental matter of the chick, and inftantly render it unfit to perform its offices. This addition of alcohol, however, prevents the white from putrefying; and hence we fee how greatly the nutrimental matter of animals tends to coagulation; and what unexpected properties may attend too great a purification of certain things. Wine will mix with the white of egg; but the alcohol, afforded by wine, coagulates therewith, tho' not if largely diluted with water.

PROCESS CXII.

The recent white of eggs analyſed by diſtillation.

'1. BOIL whole eggs in water till they become hard, then ſeparate their whites, and chop them ſmall; put them into a glaſs-body fitted with a proper head and receiver, ſet the whole body in a water-bath, and work with ſucceſſive degrees of fire, ſo as at length to make the water boil ſtrongly; there appear no veins, like thoſe of ſpirits, but only a ſimple water like dewy drops, and of this there is an incredible quantity, even above nine tenths. Continue working thus till no more liquor will riſe with the heat of boiling water; the liquor, ſo obtained, manifeſts no ſign of oil, ſalt, or ſpirit; it is pellucid and inſipid, excepting that it proves ſomewhat bitter towards the end; it is almoſt ſcentleſs, only a little empyreumatical at laſt: however examined, it affords no ſigns of its being either alcaline or acid: I have collected ſeveral pints of this water. There remains at the bottom of the body a very little quantity of matter, in proportion to the former; being only ſome little fragments ſhrunk to a very ſmall compaſs. Theſe are of a very yellow colour, eſpecially where they touched the glaſs, and yet tranſparent almoſt like coloured glaſs. When they are taken out, they prove light, hard, perfectly brittle, and ſnap with noiſe; they ſmell ſomewhat empyreumatical, and taſte a little bitter, on account of the fire; but are neither acid nor alcaline: and this is the firſt analyſis.

'2. Put theſe remaining fragments into a glaſs retort, ſo that two thirds thereof may remain empty; ſet the retort in a ſand-furnace, lute on a capacious receiver, lute the juncture, and diſtil with degrees of fire, ending with the fire of ſuppreſſion. There riſes an oily ſpirit, that runs with veins, and at the ſame time a volatile ſalt ſticks, in a ſolid form, to all the ſides of the receiver: the quantity of this ſalt is large in proportion to the dry fragments, but ſmall in proportion to the original white. At laſt there aſcends a black, groſs, and pitchy oil, beſides the lighter gold-colour'd one, mixed with the former matters; when this is brought over with the utmoſt force of fire, the earth remaining in the bottom, cloſely united with its highly tenacious oil, rarifies and ſwells up to the neck of the retort; and if the retort were too full, often comes into the neck, blocks it up, and ſometimes burſts it in a dangerous manner. The operation muſt be continued till nothing more comes over. The firſt ſpirit is oily, and in every reſpect ſtrongly alcaline; as appears by the violent effervescence it makes with acids: it reſolves by rectification into a volatile, alcaline ſalt and oil, and a fetid, indolent water. The laſt oil is ſharp, cauſtic, and highly fetid; the black earth, remaining in the retort, is ſhining, light, porous, and brittle, being alſo empyreumatic and bitter, on account of the laſt oil; if it be burnt in an open fire, it affords a little white, inſipid, inodorous fixed earth, that makes a very fine powder, but yields ſcarce any ſalt by elixation.'

The

The use.

The white of eggs, therefore, copiouſly abounds with water, but contains no alcali, that can be raiſed with two hundred and twelve degrees of heat; ſo that the matter, which with a ſtronger fire turns into volatile alcali, is not by this leſs degree diſpoſed either to volatility, or an alcaline nature, and therefore contains no volatile ſalt; becauſe we call that volatile ſalt in chemiſtry, which is more volatile than water, and riſes with a much leſs degree of heat. It contains no inflammable ſpirit, which can be raiſed by the heat of boiling water; it contains no oil which can be ſeparated by this degree of heat. Even the remainder, when the water is ſeparated, is ſtill ſo little changed by ſo great a force of fire, as to manifeſt no ſalt; whence with ſuch a heat, the fluid part being driven off, it ſpontaneouſly acquires the form of brittle glaſs. Hence we underſtand, that the volatile ſalt obtained from the white of egg, is not a natural, but created ſubſtance; for after this volatile ſalt is ſeparated from the remaining matter, by the fire, it is volatile with ſixty degrees of heat; tho' it could not be obtained before therefrom, by three hundred. Whence this volatility is not natural to the ſalt of the white, but produced by the fire: and the ſame ſeems true of its alcaline diſpoſition. Hence alſo we learn, that the oil adheres tenaciouſly to the more fixed part of the white; that the water is eaſily ſeparated from it; but that the animal coal will never let go its oil in a cloſe veſſel, or without the aſſiſtance of the open air. Theſe are the notions we ought to have concerning the white of eggs, from whence all things afterwards proceed. Certainly theſe particulars are very different from what is uſually delivered of the chemical principles drawn from animal ſubjects. But what idea we ſhould form of the ſaline matter pre-exiſting in the white of the egg, before it is committed to diſtillation, I know not; as being no way manifeſt to the ſenſes. Thus much we are ſure of, that from this indolent, inſipid, and tenacious matter, the action of the fire alone may ſoon produce ſharp, fiery and cauſtic matters, both ſaline, alcaline, and oily. But upon mixing all theſe together again, they will not recompoſe the ſame mild and viſcous matter: and the natural heat, without a previous putrefaction, does not generate alcali in the body.

PROCESS CXIII.

Recent white of eggs putrefied.

'IF ſound eggs, or their whites, be kept in ſeventy degrees of heat, or 'more, they in a few days begin to reſolve, grow thin, fetid, and 'putrefy: as alſo, if the eggs are whole, to grow empty at their obtuſe 'end; and if now boiled in water, they do not grow hard, but remain 'fluid; and this change happens much ſooner in eggs laid with, than with'out the aſſiſtance of the cock: in the latter kind, the greateſt part of the 'corrupted moiſture would exhale; whence the whole ſhell is at length 'almoſt filled only with wind or air. If an egg, or the white, be kept longer 'in

'in this degree of heat, at length almoft all its parts will ftrangely putrefy, 'turn alcaline, make an effervefcence with acids, afford an alcaline fpirit, 'and an alcaline falt for the firft thing in diftillation, perfectly like putre-'fied urine, as we faw in the hundredth procefs. But the white, thus pu-'trefied, becomes almoft totally volatile in the open air, and exhales as 'it putrefies; leaving at length fcarce any thing more than a few thin fkins 'behind: but no acid is ever here produced.

The ufe.

A fmall quantity of an egg, putrefied till it acquires this alcaline nature, has ftrange effects, if received into an healthy body; as there creating reachings, vomiting, anxiety, fhivering, a loofenefs, gripings, heat, inflammation of the bile, a fever, and thirft. And merely by its putrid exhalation it occafions fhiverings, reachings, and dizzinefs; and ftrangely diffolves down the juices of the body, like a peftilential poifon. And this, we fee, is the nature of that matter which is immediately changeable into the form and fubftance of all the parts of an animal body: reft, and fuch a degree of heat produce thefe alterations. And hence we fee the fpontaneous tendency of this matter to corruption and change; yet what feems highly wonderful, a prolific egg kept in a ftove-room, heated to ninety-two degrees, diftributes the parts, fo attenuated and altered by that heat, in nourifhing, augmenting, and perfecting the chick, in one and twenty days; and yet this chick contains nothing alcaline, fetid, or putrid. Phyficians may here obferve a wonderful change of things by fuch a heat, and reft; what was thick becomes thin; what was tenacious refolves; what was inodorous becomes fetid; what was infipid becomes naufeous, and of an abominably corrupted tafte; what was mild becomes cauftic; what was neutral becomes alcaline; and the fweet latent oil becomes highly putrefied and loathfome. Let thefe particulars be compared with thofe obferved by *Malpighi*, in his treatife *de ovo incubato*, and they will be found furprifing. I have endeavoured to perform thefe experiments chiefly upon the white of eggs, feparated from the other parts, becaufe the white is the only matter deftined to feed the chick; the reft only ferving to change this, and diftribute it for the perfecting of the chick.

PROCESS CXIV.

Recent ferum of human blood, fhewn to be neither acid nor alcaline.

'1. WHEN blood is drawn from a wide orifice, made in the vein of 'an healthy perfon, before eating in the morning, into a clean vef-'fel, and fuffered directly to reft, it foon feparates into two parts, *viz.* a 'folid concreted cake, and a yellow thin liquid ferum, which continually 'increafes upon the fame mafs, if fuffered to reft long. Separate this fe-'rum as carefully as poffible from all the red part, and put it into a clean 'veffel. If the ftrongeft vinegar be added to one portion hereof, no effer-'vefcence arifes; add fpirit of falt to a fecond, fpirit of nitre to a third, and

'oil of vitriol to a fourth; and in none of these cases will any signs of
'effervescence appear.

'2. In two other vessels put two portions of the same serum, and with 'one of them mix fixed alcali, with the other the volatile kind, and 'thus also they make no conflict, nor give any sign of a saline effervescence.

'3. If now the serum, mixed with fixed alcali, be poured to that mixed 'with spirit of salt, a violent effervescence presently arises, so as to make 'the whole possess above ten times the space it occupied before; thus oc-'casioning a much greater ebullition than that of milk over the fire, and 'this even in the cold.

'4. This serum has a mild but latent saline taste, an ungrateful odour, 'but no way sharp or brisk; if a drop of it be let fall warm into the eye, it 'gives no pain, but is reckoned an immediate asswager in inflammations and 'wounds of the eyes; and when applied to the nerves, laid bare by wounds 'or ulcers, it is scarce felt.'

The use.

1. I have frequently observed the blood of healthy persons, as it has run from the vein in bleeding, started from the arteries in wounds, flowing from the nose in hæmorrhages, coughed up from the lungs upon the bursting of an artery; and again in dogs, sheep, oxen, and other creatures, upon being wounded or killed. I have also observed the blood rushing violently from the veins of persons that were blooded in burning fevers, phrensies, or the like; but upon examining it carefully, at the very instant it was received into a vessel, from the living body, I never found the least sign of any ebullition, effervescence, fermentation, intestine motion, or rarefaction; tho' it was a little before violently agitated by so rapid a motion in the vessels of the body. Upon making these experiments, with care, some years ago, I at length changed the opinion I had imbibed from the reading of chemical books, especially those of *Sylvius*; for I certainly found that the senses could not discover any acid or alcaline principles in the blood, so as that these should be able to produce visible effects upon their mixture; such as ebullitions, effervescences, fermentation, intestine motions, or rarefactions; and hence concluded that they are not in the body; because, otherwise, they must appear at the instant the blood is discharged. If it be said they are there, but in so mild and gentle a manner as not to appear, I only ask how this can be proved. Certainly, thus much is plain, that if these opposite chemical salts do reside in the blood after such an indolent manner, they must be so weak as to produce no sensible effect, and therefore it is not safe to explain any sensible effect by supposing them.

2. The blood of a healthy person, left to itself, may be rather esteemed a solid than a fluid; and yet the solid thence produced again spontaneously resolves into a liquid: this is a strange thing but certain. If drawn upon an empty stomach, it separates spontaneously, not as milk into cream, and a more wheyish part, but into a concreted mass, and a liquor: the liquor of itself is yellow, and the red concreted mass purple, where it touches the air, but black in the middle of the mass, where the air cannot penetrate; but

but it gradually loſes its redneſs in the air, and grows yellow, like the ſerum. There is no acid nor alcali found either in the ſerum, or any other part, that when mixed with its ſuppoſed oppoſite ſhews any ſigns of effervescence; but they reſt as quietly together in this reſpect, as water does with water.

3. Hence it appears the diſpoſition of the human blood is ſuch, that if acid and alcaline ſalts were at once to meet in it, they would inſtantly cauſe ſuch an expanſion, that the rarified maſs would ſwell into at leaſt ten times its former ſpace, and immediately after this ſudden expanſion ceaſed, fall down again, and return to the former bulk: which is an operation abſolutely repugnant to the nature of the body, and the uniform continuance of health and life.

4. This ſerum contains all the matter which circulates thro' the veſſels of the body, except the red part, and therefore holds whatever afterwards arrives at any veſſel, whether great or ſmall; that is, contains the nutrimental matter for ſupplying all the parts requiring growth, or repair; and conſequently, the matter of the whole body, both ſolid and fluid. Hence appears the excellent uſe of this experiment in all caſes relating to the body; and thus we hope, that chemiſtry may rectify thoſe errors wherewith it had infected phyſic and philoſophy. This ſerum is mild, indolent, and forms all the parts of the body, exactly like the white of eggs; for as all the parts of a chick proceed from the white of the egg, ſo do all the parts of the human body proceed from the ſerum.

PROCESS CXV.

The ſerum of the blood putrefied by digeſtion.

'IF the ſerum of the blood be ſet in a tall open glaſs, with a heat of 'ſeventy degrees, it will ſoon begin to grow thin, and continue to do 'ſo every hour, ſo as in three or four days to become liquid, and ſanious, 'fetid and cadaverous; and inſtead of the inſipid and almoſt ſcentleſs thing 'it was, to acquire a rancid, ſharp, and abominably corrupt taſte and ſmell. 'And if kept thus a few days longer, it becomes alcaline, putrid, intolerable to the ſenſes, and manifeſts an acquired alcaline nature, by making 'an effervescence with acids. If it be now diſtilled, it affords a volatile, 'alcaline ſalt for the firſt thing, exactly as the white of eggs treated in the 'ſame manner, according to the hundred and thirteenth proceſs.'

The uſe.

The ſerum, therefore, as examined by the ſenſes, grows ſpontaneouſly thinner by reſt, and a determinate heat; and, therefore, when ſtagnating in the obſtructed veſſels of an unhealthy perſon, it often ſpontaneouſly reſolves with a gentle warmth and time, ſo as to open the parts that were before obſtructed. Hence in acute inflammatory diſtempers, if the heat of the body be reduced to mediocrity, the fluids, that were coagulated, may be rendered fluid again, in a certain number of days, as we often find in the prac-

tice of physic. The serum never turns acid by the change it undergoes in this experiment, whatever some eminent artists may have wrote to the contrary, but always putrefies without suffering any other change: no signs of fermentation here ever appear, even tho' all the means for promoting it were used, but only a determinate putrefaction. It is true, that putrefied bodies rarify and produce elastic fugitive air, but not the fermenting spirituous kind. Neither are inflammable spirits generated in this putrefaction, as by fermentation, but others of a putrid volatile kind, tho' indeed inflammable; for the fæces detained in a jakes that has no vent, so as to be strongly compressed, conceive a violent intestine motion, and discharge very fetid exhalations, which have catched flame upon the approach of a candle. And hence it sometimes happens that heat and rarifaction are excited in the human carcass; but this is chiefly about the *abdomen*, and not very great. And hence physicians may learn how the juices of the body will spontaneously degenerate, when extravasated, or obstructed. Lastly, this putrefaction is hindered by means of acid, compound-saline, and spirituous liquors.

PROCESS CXVI.

The serum of the blood coagulated in boiling water.

' LET serum fall into boiling water; it presently turns white, and appears coagulated therein: in which respect it again agrees with the white of egg, as in the hundred and tenth process; tho' the white of egg coagulates stronger in the water than the serum.

The use.

Hence we see the effect of heat upon the serum of the blood; and the action of boiling water upon the juices of the body, when it comes in contact with the live parts, so as to scald them: and hence also it appears that neither the saline nor oily part of the blood is rendered volatile by this heat.

PROCESS CXVII.

The serum of the blood coagulated with a dry heat.

' PUT serum into a clean vessel, and gradually heat it over the fire; when it begins to fume, the part that touches the vessel begins to turn opake, white, and to coagulate, till in a short time the whole serum (but the middle part on the top last) concretes into a white, tenacious, opake, horny matter, waved on the middle, at the top entirely solid, of a mild taste, like the boiled white of egg, and almost scentless. This mass, being kept in the open air, by degrees sweats out a thin aqueous liquor, exactly after the manner of boiled white of egg; but if this coagulation be properly made with a moderate fire, or with a degree of heat barely requisite for that purpose, it concretes without any empyreuma,

' without

'without feparating any falt, or manifefting any fign of being alcaline; and 'when thus coagulated, it can fcarce be refolved by any other means.'

The ufe.

Hence it appears that all the fluids of the body may be coagulated or concreted into maffes, not capable of paffing the veffels, with a certain degree of heat, not much greater than a hundred degrees; and therefore that the body cannot endure a degree of heat, tho' but a little greater, whether from an external or internal caufe, without a ftoppage of the circulating fluids, and the death of the perfon: the defect firft appearing in the brain and lungs, the actions whereof are thus prevented. And hence we underftand, that the heat which coagulates the juices may prove mortal, long before the falts and oils become alcaline, putrid, and volatile, by the fame means. Hence the little mercurial thermometers made by *Fahrenheit* are extremely ufeful in all thefe cafes; and hence juft prognoftics may be made from the degree of heat in acute difeafes.

PROCESS CXVIII.

The ferum of the blood coagulated with alcohol.

'TO a quantity of ferum, contained in a clean veffel, pour a little pure 'and cold alcohol, and the ferum will immediately grow thick, 'white, and opake, where the alcohol touches it; and when the two are 'fhook together, all the fame phænomena happen, and the whole is coagu-'lated as in the white of eggs, though not fo ftrongly, but in pieces. 'When the alcohol is poured on very hot, and fhook with the ferum, the 'coagulation proves much ftronger. The alcohol, thus poured on and coa-'gulating, preferves the ferum from corrupting afterwards; fo that it may 'now be preferved, for years, unchanged.'

The ufe.

1. Hence we find a new agreement between the ferum of the blood, and the white of eggs, in refpect of their coagulating with alcohol. The reafon why the ferum does not here coagulate into fuch a denfe mafs as the white of eggs, feems owing to the greater folidity of the white of the egg, which is entirely deftined to nourifh the chick contained in the fhell; and is neither in the leaft corrupted, nor fo thin as ferum, which retains fome mucous part of the blood, and much water.

2. But alcohol diluted with water does not thus condenfe the ferum, nor the white of eggs; and hence we may underftand the effects of pure alcohol upon the blood, which it condenfes like fire, and preferves from all fpontaneous putrefaction; and in both thefe refpects it becomes an immediate ftyptic; at the fame time preventing putrefaction, and occafioning a thin indeed, but very folid efcar. For if pledgets be dip'd in pure alcohol made hot, and applied to a bleeding wound, if it be clofely compreffed upon the part, and covered with a piece of bladder, lightly befmeared with oil, and kept

on with a proper bandage, the hæmorrhage presently ceafes ; and the whole dreffing may continue unremoved for three days, in which time the veffels are ufually clofed, and ftrangely contracted and confolidated by means of the alcohol. This liquor alfo coagulates the groffer juices of the body like fire, and contracts the fibrous parts, rendring them hard and dry, and preferves both from fpontaneous putrefaction, as Dr. *Cabelliau* has fhewn, by an extraordinary example, in a leg that was mortified, but by means of fpirit of turpentine, and the alcoholized fpirit of juniper, kept without amputation, fo as not to putrefy farther for fix months (*a*). But the parts of the body, confifting of fmall veffels, foon grow hard, together with their juices, in alcohol ; whence it is no wonder that the perfons, who ufe inflammable fpirits too freely, are fubject to fuch violent diforders of the nerves and concretions in the blood.

PROCESS CXIX.

The analyfis of the blood by diftillation.

'TAKE the blood of healthy perfons, drawn from the arm by way ' of prevention, in a plethoric habit ; put it into a glafs body, fo ' as to fill only one third thereof ; lute on a glafs head, fit on a receiver, ' and work, in a bath-heat, with a fire of a hundred and fifty degrees. There ' will thus rife into the alembic-head, dewy fcattered drops like pure water, ' without any fign of a fat fpirit. Continue to work fo long as any moif- ' ture comes over tolerably quick, with this degree of fire, and preferve this ' apart ; it will have the gravity, the colour, and fluidity of water, and be ' almoft without fmell and tafte ; it makes no effervefcence with any acid ' or alcali, but quietly mixes with them both : it manifefts nothing faline ' or oily ; when dropped into the eye it does not prove at all fharp ; and ' quenches flame when thrown thereon : whence it is almoft water.

' 2. Now raife the fire, fo as to make the water of the bath boil, and a ' like aqueous volatile liquor comes over ; continue diftilling with this heat, ' till no more rifes ; which requires a confiderable time, becaufe towards the ' laft, when the mafs begins to dry, the liquor rifes with difficulty. This ' fecond liquor, is in every refpect, exceedingly like the firft, fo that all the ' experiments above related hold true thereof, without any difference : which ' is a thing I recommend to be carefully obferved and remembred. Thefe ' two liquors make almoft feven eighths of the blood employed.

' 3. The glafs-body being now broke, and the remaining mafs taken out ' and examined, does not by any experiment feem alcaline, acid, or fharp, ' but unactive, and fomewhat empyreumatical ; and if kept in a dry place, ' included in a wooden unpainted box, it may long be preferved without ' change ; or it may be reduced to powder, and thus preferved, as apothe- ' caries do by goats blood.

(*a*) See *Ephem. Germ. Dec.* III. p. 495.

' 4. This

‘ 4. This maſs being pulverized, and put into a glaſs retort, whoſe neck ‘ is cut off ſo as to leave a very wide mouth, and the retort remaining ‘ one third empty, diſtil with degrees of fire in a ſand-furnace, and a ſome- ‘ what unctuous, oily, bitter, and lightly alcaline liquor comes over; then a ‘ white, ſolid, volatile ſalt, ſticking to the ſides of the receiver and neck of ‘ the retort. Increaſe the fire by degrees, and thus a gold-coloured oil, ‘ always attended with ſalt, will be forced over. Apply a freſh receiver, ‘ and uſe a ſtrong fire of ſuppreſſion; white fumes will now aſcend, and ‘ would, perhaps, never ceaſe, and along with theſe a groſs fat oil: and ‘ now the maſs at the bottom of the retort, being fuſed, rarified, and ſwelled, ‘ riſes into the neck of the retort, which it blocks up, and, with a violent ‘ noiſe and force, inſtantly burſts the veſſels to pieces in a dangerous manner, ‘ as I have learnt by experience: this may be prevented by chooſing a retort ‘ with a wide neck, and cut ſhort, ſo as to leave a very open mouth. There ‘ are thus obtained an alcaline oily ſpirit, a volatile alcaline oily ſalt, a ſalt a ‘ little more fixed and more oily, a yellow oil, and one that is black and ‘ pitchy; all of them containing alcali, exactly as we found in diſtilling the ‘ white of eggs, according to the hundred and twelfth proceſs, from which ‘ the preſent differs but little.

‘ 5. At the bottom of the retort, there remain very black, ſhining, ‘ ſpungy, light, fetid, empyreumatic, bitter, but ſcarce ſaline fæces, which, ‘ being urged in a cloſe veſſel, till the retort was almoſt melted, I could not ‘ by the force of fire bring to that ſtate, as to fume no more: this matter ſtill ‘ retained its blackneſs, ſo that it is the true coal of blood. If urged with ‘ an open fire, it takes flame, the blackneſs is conſumed, and a white earth ‘ left behind; in which no fixed alcaline or acid ſalt can ever be found, tho’ ‘ it often contains ſea-ſalt, unchanged by the vital actions: ſo that if diſtil- ‘ led with the utmoſt violence of fire, along with its own earth, it might ‘ afford ſome acid. All theſe particulars therefore ſhew, that the white of ‘ eggs, and the ſerum of the blood are nearly the ſame thing; only that one ‘ is at reſt in the ſhell, and the other briſkly circulated thro’ the veſſels of ‘ the body. They who have wrote that phoſphorus may be obtained from ‘ this laſt matter, may perhaps ſay true; but I queſtion whether they ſpoke ‘ by experience, becauſe there is ſo little of theſe fæces left behind by the ‘ blood. It is eaſy to argue by analogy, but much more laborious by ex- ‘ periments.’

The uſe.

Hence it is certainly ſhewn, that water, and a ſomewhat fetid ſpirit, are the moſt volatile parts in the juices of the body; that water makes by far the greateſt part thereof; and that the natural ſalt of the blood is never ſo volatile in the body, as to riſe with a heat twice and a half as great as that of the body, or even almoſt thrice; whereas a degree of heat, one tenth part greater than that of the body in health, ſoon proves mortal. Hence alſo it is manifeſt, that no volatile alcaline ſalt can riſe with a degree of heat three times greater than the natural; and conſequently that ſuch ſalt is not then preſent: that the pitchy oil ſtrongly coheres with the earth of the blood;

blood; that the blood, deprived of water, manifefts no faline principles, and that thefe at that time neither act or are changed, but may lye mixed together at reft, and unactive for years, tho' they may be extricated by fire; that the blood may be infpiffated by fire, fo long as the heat continues lefs than is required to make the blood afford a volatile alcaline falt; that the blood infpiffated with this degree of heat, may again have a large part thereof converted into a volatile fluid by a ftronger fire; and that the parts fo feparated may, except a very little earth, remain afterwards fluid and volatile. We have feen that there are no inflammable fpirits in the blood; that the falts of the blood which are not at firft volatile with two hundred and fixty-fix degrees of heat, yet when once rendered volatile, can fcarce be kept from fpontaneoufly flying off with a heat of thirty-two degrees; that the falts of animals may by a ftrong fire be rendered volatile and alcaline, tho' they were not fo before, and be made to remain in this ftate: that the feparated principles of the blood do not, when mixed together again, recompofe blood, but make a very different thing; and therefore that fire acts with a ftrange diverfity upon the blood, according to the degree wherein it is applyed: below a hundred degrees, down to fifty, it attenuates and putrefies it; from a hundred up to a hundred and feventy-fix, it infpiffates it; and beyond this degree again, it attenuates it, and renders its parts volatile, fharp, and alcaline: and hence we may underftand what the aliment, the chyle, the milk, the ferum, and the productions thereof are in their origin, kinds and effects: and all thefe particulars I have found perfectly the fame in the blood of many brutes.

PROCESS CXX.

The analyfis of horfes hoofs, by diftillation.

'1. TAKE the parings of horfes hoofs, whilft at grafs, as they are 'cut off by the farrier, and fteep a fufficient quantity thereof in 'water, that they may be cleanfed, and afterwards dried; put them into a 'glafs retort, fo as to fill it almoft to the neck; fet the retort in a fand 'furnace, apply a very capacious receiver, and lute the juncture with a 'pafte of linfeed-meal; diftil with flow degrees of fire. There will firft 'come over a limpid aqueous liquor in dewy drops; continue the fame heat 'fo long as this liquor diftils; then pour it out, and keep it apart; apply 'the receiver afrefh, and raife the fire, till white clouds begin to rife, at 'which time a fat fpirit will come over in oily veins; continue with this 'degree fo long as it will bring any thing over; there will be now fome 'figns of a faline matter. Increafe the fire again, and along with the unc'tuous fpirit there will come over a volatile alcaline falt, fhooting up in lit'tle lumps, together with an oil; continue this fire till fcarce any thing more 'rifes; then increafe it to the utmoft; at length raifing a fire of fuppreffion; a 'fomewhat more fixed volatile falt, along with a very thick red oil, will now 'come over; at which time the fæces fufing will run into a mafs that fwells 'and rifes up to the neck of the retort. Now ceafe the operation, and take

'away the receiver before the retort is thorougly cold, otherwiſe the vo-'latile ſalt will in a great meaſure go back into the retort: keep the pro-'ductions in a well-ſtopped glaſs, for they are exceeding volatile. The 'remaining fæces are very ſharp, light, ſpungy, as alſo fetid and bitter, 'and, if calcined in an open fire, afford a little quantity of white, inſipid, 'and conſiderably pure earth.

'2. If hartſhorn, which has been kept for many years, and is now grown 'exceeding dry, be broke into large pieces, and put into an iron pot ſet in 'a furnace, and fitted with a large earthen alembic-head, that goes with a 'double pipe into two capacious receivers, and the diſtillation be carefully 'performed with degrees of fire, nearly all the ſame matters will be ob-'tained; *viz.* a fat, oily, alcaline ſpirit, a volatile ſalt, a light oil, a ſalt 'ſomewhat more fixed, and a groſs pitchy oil; there will remain behind 'a ſolid black coal, that does not eaſily diſſolve by fire, but remains brittle, 'and when reduced to powder; and given upon an empty ſtomach, it 'proves an excellent medicine for deſtroying worms.

'3. The recent bones of animals, cleared as much as poſſible from their 'fat, and treated in the ſame manner, afford the ſame matters; only abound-'ing with more of a highly fetid nauſeous oil, that infects every thing it 'touches. Horns, nails, hoofs, hair, and ſilk afford the ſame.'

The uſe.

As a greater or leſs quantity of water is drawn from all theſe, even the drieſt bodies, it ſhews how intimately water may adhere to the other principles of animals, and be conſolidated therewith into an extremely hard and dry form, ſo as to remain fixed for numerous years, and at length be releaſed again by the means of fire. This principally appears when the fluid ſpirit is ſeparated from its volatile ſalt and oil; for then a conſiderable quantity of fetid water is left behind: and hence it appears, that the moſt perfectly inodorous bodies may, by the bare force of fire, acquire many degrees and kinds of fetid odours, whilſt each part, ſeparate from the reſt, has a peculiar odour, which it tenaciouſly retains for a very long time: and the ſame holds true of the variety of taſtes produced from an inſipid body: for the water, ſpirit, ſalts and oil, have each their particular odour. Again, from a ſolid body we have various fluids, which concrete together again with the greateſt difficulty, ſo as to form a fixed body; we have ſeveral alſo that are volatile from fixed bodies; and there remains from ſo large a bulk but little earth, which is firm and fixed. And as the ſame principles are obtained both from the ſolids and fluids, tho' always more earth from the ſolids; we hence ſee the common nature of both, and therefore that the ſolids are compoſed of the fluids; but the larger bones calcined to perfect whiteneſs, both in their ſurface and ſubſtance, with a clear and violent fire, ſtill retain the former ſize and figure; yet if afterwards expoſed to the action of the fire in a cloſe veſſel, they afford no water, ſalt, ſpirit, or oil, but remain crumbly, yet ſo, as if dipped into water, or oil, they again acquire a tenacity. So likewiſe if horns, bones, or the like parts, be ſtrongly boiled for a long time in water, with a repeated change of the water, and a ſeparate reſervation of the former decoctions, and this be con-

tinued till the water comes off pure, after boiling with the bone, and all theſe decoctions be inſpiſſated to a thick coagulated maſs without burning, ſo as to appear almoſt like horn in the cold; then this maſs, ſo prepared from hartſhorn, ivory, bones or fleſh will, by diſtillation, afford all the principles, in the ſame manner as the other ſubjects of this proceſs. But the horny or bony matter, remaining after this thorough decoction, affords ſo much the leſs ſalt, oil, and ſpirit, the more jelly was obtain'd by the boiling; from whence it ſeems, that all the ſaline, ſpirituous, and oily matter proceeded only from the juices, whilſt the laſt ſolid is a mere ſimple earth that can ſcarce cohere together, and containing, after having ſuffered the utmoſt violence of the fire, no fixed ſalt, but always affording, when burnt to whiteneſs, a proper kind of aſhes for making the refiners teſts. And when bones are treated in *Papin*'s digeſter, I have found, by repeating the operation, that they remain almoſt wholly terreſtrial after boiling. And this has ſhewed me that ſcarce any obſervable difference could be found in theſe productions, let the animal ſubject be what it would; except only in reſpect of the oil, which abounds more plentifully in one part, than in another. The oil, in the diſtillation acquires a perfectly intolerable fetid odour, that infects all the things it touches with an abominable taſte and ſmell, not to be got out. And hence the ſolid ſubſtances, thus diſtilled, afford theſe productions the more infected and diſagreeable, the more oil they contain: and hence it is that hartſhorn, which is leſs unctuous, affords a leſs nauſeous oil and ſpirit than ox-bone, which is full of marrow; but except this ſingle difference, they can ſcarce otherwiſe be diſtinguiſhed: for all theſe ſpirits and ſalts, purified from their oil, become the ſame thing; nor could I ever find any difference betwixt theſe productions, yielded by different animals: for horſes hoofs, the horns of oxen and ſtags, ivory, tortoiſe-ſhell, hair and ſilk, afford all the ſame. Whence it is of little conſideration from what ſubject theſe things are produced; only with reſpect to the oil, as above explained. I could never find that the ſpirit of human blood, hartſhorn, horſes hoofs, or raw ſilk, differed in any thing but the oil. *Helmont*, I know, recommends the ſaline ſpirit of human blood before all others, becauſe it cures the falling-ſickneſs; and in *England*, *Goddard*'s drops, diſtilled from ſilk, are preferred to others of the ſame kind; but I have long obſerved, that theſe differences are ſeldom found with any certainty in the practice of phyſic. This is certain, that all the matter capable of affording theſe principles by diſtillation, may be extracted by diſſolving animal ſolids in boiling water; whilſt what remains, after a thorough boiling, will afford little thereof: therefore in theſe almoſt inſipid and ſcentleſs decoctions, all that matter lies concealed, which affords ſalts, ſpirits, and oils by diſtillation; therefore theſe ſalts of animals could not be rendered alcaline or volatile, by ſo long and repeated a boiling. It is alſo certain, that the air, water, and ſun, do at length deprive the bones expoſed thereto, of all that animal matter, which, in diſtillation, would afford water, oils, ſalts, and ſpirits; and in old bones grown thoroughly white, is found, upon committing them to diſtillation, nothing of theſe principles, but only a ſimple earth; putrefaction having carried away the reſt. It is an agreeable experiment to boil an animal muſcle, or for example, an ox's

heart, ſo long in ſeveral waters, till at length the laſt water comes off as pure as it was put on; then gently ſqueezing the water out of the heart with the hand, and repeating this ſeveral times, and boiling it in freſh water, the external thin membrane being taken off, that the fat alſo may be reſolved and ſeparated in the boiling, there will thus be at length obtained a perfectly ſolid, dry, and incorruptible muſcle, exhibiting all the fibres; eſpecially if hot water has been firſt injected with a ſyringe, thro' the coronaries, ſo as perfectly to waſh out the blood from the veins and arteries; for thus the mere ſkeleton of the muſcle will be obtained.

PROCESS CXXI.

The manner of depurating and ſeparating the productions of diſtillation from alcaleſcent, burnt, or putrefied vegetables, according to the thirty-third, eighty-ſixth, and eighty-eighth proceſſes; and again, from animal ſubjects, according to the ninety-fifth, hundred and firſt, hundred and twelfth, hundred and nineteenth, and hundred and twentieth proceſſes.

'1. TAKE all the productions of diſtillation in the proceſſes here mentioned, and put them together into a large glaſs-body, to be hereafter kept for this purpoſe; apply a large capacious head, with its pipe cut in the wide part, ſo that the ſalt may eaſily paſs into the receiver, otherwiſe it would there ſtop, block up the pipe, and forcibly throw off the head. Set the veſſel in a bath-furnace, with a continued heat of a hundred and fifty degrees, ſo as firſt to bring over what will riſe with this degree: a fat, volatile, alcaline ſpirit thus comes over, along with a white ſolid ſalt. When no more aſcends, change the receiver, and keep this liquor, with its volatile ſalt, apart; and if the ſalt, by ſhaking, does not diſſolve in its ſpirit, it is a ſign that the ſpirit, being poured out, and kept ſeparate, is as ſtrong and rich as can any way be procured: let it therefore be kept for its particular uſes, in a cloſe-ſtopped glaſs, under the title of ſpirit of hartſhorn, ſpirit of human blood, &c. And let the ſalt alſo, which would not diſſolve in this ſpirit, be preſerved under the title of the volatile oily ſalt of hartſhorn, or of whatever elſe the ſubject was.

'2. Urge the remainder with the heat of boiling water, and there will come over another ſpirit more ſlowly than the former, together with a light oil floating thereon, and ſome quantity of volatile ſalt: continue thus till no more riſes with the ſame degree of heat; and again, keep this aqueous, oily, and ſaline liquor ſeparate: a groſs fetid oil will now remain at the bottom of the veſſel.

'3. Thus we obtain, from the above-mentioned productions, a water that is neither oily nor ſaline at firſt, as we ſaw in the beginning of the preceding proceſs; next, an alcaline oily ſpirit; thirdly, a volatile oily ſalt; fourthly, a volatile oil, with an oily alcali, a little more fixed, and a fetid

'water; fifthly, a more fixed oil than could be separated by a heat of two 'hundred and thirteen degrees.

'4. If the first spirit be again distilled in a fresh glass, with a hundred 'degrees of heat, the salt is thence obtained purer, and almost in a solid 'form. And if the operation be continued, till the salt sublimed begins to 'dissolve by the subsequent liquor, an aqueous fluid will remain at the bot- 'tom, with an oil floating thereon: so that these spirits consist of an ex- 'tremely light water, oil, and salt united together; whence they again resolve 'into these three. This spirit therefore is a volatile saponaceous lixivium; and 'the remaining water and oil may be so separated, by a fresh distillation, that 'the water shall remain tasteless, tho' fetid, and the oil almost without mix- 'ture; all the salt being separated with the more volatile oil: and hence we 'may understand the nature of these spirits. But the salt separated, by this 'sublimation, from its spirit, is always oily, tho' less so than the former, 'and therefore much whiter; because upon each rectification it leaves a yel- 'low, and sometimes a red oil behind, which gave it the colour. But when 'the spirits that are not oily, as those of the hundred and sixth process, 'but merely alcaline and aqueous, are thus treated, then only a pure vo- 'latile alcaline salt arises by itself, in a dry form; leaving the water so 'much less alcaline at the bottom. Hence we learn, that the animal salt, 'once rendered volatile and alcaline by putrefaction, the admixture of fixed 'alcali, or the force of fire in distillation, thereby becomes and remains 'more volatile than pure water, and the most volatile oils: and hence, that 'the water, so deserted, manifests the oil it concealed before, as being united 'with its alcali into a kind of soap, soluble in water: and now, when the 'alcali is separated, the oil will no longer continue mixed with the water, 'but fluctuates apart.

'5. Let the oil, which remains after the depuration of the spirits, be poured 'to that remaining at the bottom, as above-mentioned, and mix'd there- 'with; then pour warm water to them, and shake them together, whereby 'the salt, that might chance to remain fixed with the oil, will be dissolved in 'the water; and hence the caustic sharpness of the oil will be got out, and the 'oil itself be rendered more mild: let this saline water be poured off, that the 'salt may afterwards be separated from it by sublimation. Then let these 'oils be put into a glass-body, and with the heat of boiling water be freed 'from their aqueous moisture, till no more thereof will arise; then put 'the oils into a retort, and distil, with a gentle heat, into a capacious re- 'ceiver, gradually increasing the fire to the highest degree sand will give, 'till nothing more comes over; and thus the oil will become more thin, 'limpid, and less fetid: a black earth remains behind in the retort: and if 'the oil, once drawn off, be a second time returned, and distilled upon its 'own black fæces, it again becomes more pure, limpid, thin, and less fetid; 'again leaving more earth behind; and this happens upon numberless co- 'hobations. But I have scarce found any end in the operation; for I have 'formerly, according to the direction of *Helmont*, in his *aurora medicinæ*, 'endeavoured, with great patience, to prepare the oily diaphoretic medicine 'he there prescribes; and he directs the purification of these oils by distil-

'lation,

'lation, so often repeated, till at length they leave no earthy fæces be-
'hind. I, therefore, distilled oil of hartshorn in the manner above-men-
'tioned, and cohobated it a number of times, but always found a black fe-
'culent matter left behind; so that I at length lost a part of the oil, and
'gained a great quantity of earth, and still found more earth at the bottom
'of the retort. But thus I obtained a very penetrating, and not ungrateful
'oil. Whence I conceive that *Helmont*, perhaps, never brought the expe-
'riment to a conclusion, in the manner he directs it; and that the illustri-
'ous Mr. *Boyle*, with greater veracity, writes in his treatise concerning the
'transmutability of the chemical principles, that, by many continued coho-
'bations, at length almost the whole quantity of these oils is converted into
'earth, with a constant loss of that acrimony which remains in the oil after
'the salt is washed out. In the mean time, it is worth the while to co-
'hobate these oils fifteen times over: for thus they will become thin, pel-
'lucid, penetrating, and volatile, almost like spirit; of a penetrating taste
'and odour, and will strangely enter all the parts of the body. They are
'anodyne, soporiferous, and resolving, good in fevers, and grateful to the
'nerves, and cure intermittents by being rubbed externally along the back-
'bone, before the cold fit. Their dose is from twenty to thirty drops (*a*).
'And thus these oils are reduced to a very large quantity of earth, and a
'very small one of true oil: and thus the greater part of them at length
'nearly acquire the same nature, and afterwards can scarce be distinguished
'from one another: so that all distilled animal oils, thoroughly depurated
'from the other principles, seem to be one and the same thing, from what-
'ever animal they were obtained.

'6. The volatile salts of animals are depurated several ways, so as to
'render them at length perfect and without mixture. (1.) Take a large
'cut glass-body, and put into it the volatile salts to be rectified; apply a
'glass-head with a capacious receiver, and distil with a gentle sand-heat; the
'salt will rise into the head and the neck of the glass; continue the ope-
'ration till no more rises. Let the salt be taken out, and kept in a close
'glass; an oil and a fetid matter will be left behind. But in this method
'some oil always rises with the salt; tho' it may, by sublimation, be in a
'great measure left behind, and the salt be obtained the purer. And thus
'the salt of urine, white of eggs, blood, horns, and bones, are made to
'appear as the same thing: for by repeated sublimation I have brought them
'to such a likeness, that I could scarce distinguish between them; and this
'always the less, the oftner the sublimation was repeated: whence it may
'appear, that all the difference of these volatile salts depends wholly upon
'the empyreumatic oil adhering thereto; which, when perfectly separated,
'leaves them all alike: but the salt, whitened by this operation, grows yel-
'low with keeping; the oil, that was concealed, thus again manifesting it-
'self. This those chemists find, to their disadvantage, who prepare salt of
'hartshorn for sale; where an agreeable and permanent whiteness is princi-
'pally required. I have therefore found the following method more suc-

(*a*) See *Dippel.* and *Hoffm.* Obs. Chym. Phys. *cap.* 1.

cessful.

'cefsful. (2.) Put the falt, obtained by the preceding fublimation, into a 'tall glafs-body, and immediately throw thereon four times its weight of pure, 'hot, dry chalk, reduced to fine powder, fo as every way to cover the falt; 'then immediately lute on a dry alembic-head, which, the larger it is, and 'the wider its pipe, the better; lute on a receiver, and diftil with a warm 'heat in water: all the falt will thus rife white, pure, alcaline, and volatile, 'whilft nearly all the oil is detained in the dry and thirfty chalk. In the mean 'time, this addition of chalk will not change the nature of the falt, but only 'keep back its oil, and thus feparate it from that foulnefs; and the falts, 'thus prepared, may be long kept without changing; efpecially, if before 'fublimation, they were well ground with the chalk: but in that cafe much 'of them would be loft, or fly off into the air in the grinding, and the re-'mainder would prefently diffolve by attracting the moifture of the air. (3.) 'Laftly, if, when the falt is thus depurated, by means of chalk, as much 'pure fpirit of fea-falt be mixed therewith, as fuffices to faturate it perfectly, 'and the fal-ammoniac, thus produced, be diffolved in water, perfectly fil-'tred, and infpiffated into a falt, and this falt diftilled with fixed alcali, 'according to the hundred and fixth procefs, a pure, folid, white, alcaline, 'falt rifes, which is the moft genuine that can be procured, and perfectly 'free from oil: this beautiful invention is exactly defcribed in the *Philofo-'phical Tranfactions* (*a*). When thefe volatile, alcaline, oily falts are, by 'thefe three methods, reduced to their utmoft purity, there appears no fen-'fible difference between them, whether they were fpontaneoufly generated in 'the fubject, or produced by putrefaction, or by fire; and they are obtained 'perfectly in the fame form from birds, land animals, and amphibious crea-'tures, fifh, reptiles, fubterraneous animals, alcalefcent vegetables, foot, *&c.* 'for as they all, when deprived of their fpirit and oil, afford the fame fpe-'cies of fal-ammoniac, along with the fpirit of fea-falt; fo this fal-ammo-'niac, being afterwards refolved by fixed alcalies, affords the alcaline falt 'and fpirit of the hundred and fixth procefs. Hence, therefore, pure vola-'tile alcali is but one thing in nature, when obtained pure; but the dif-'ference found in it always depends upon the admixture of fome other 'principle, efpecially the oil cleaving thereto, which is very different in 'different fubjects, altho' the principal difference of the oils is owing to a 'very fmall quantity of fpirit. Hence we fee, that the water, earth, and 'falt of animals, when, by the means above-mentioned, reduced to their ut-'moft fimplicity, are perfectly the fame without any difference; fo that the 'peculiar characteriftic of each is principally lodged in the oil alone; the oil 'itfelf being diftinguifhed by its fpirit, which, when perfectly taken away, 'oils themfelves alfo become wonderfully alike. This prefiding fpirit, there-'fore, conftitutes the true difference in animals, as we above obferved it 'did in vegetables: and thefe are the ultimate and fimple effects of a che-'mical analyfis. If the artift here endeavours to proceed farther, he will 'be in danger of lofing his fubject; the particles whereof are now apt to 'fly away: for when the principles are thus purified, they do not greatly

(*a*) *Lowth.* abridgm. vol. III. pag. 335.

'cohere

'cohere together; tho', by differently uniting with one another, they form 'a vaſt variety of compounds.'

The uſe.

The chemical properties and virtues of this pure, volatile, alcaline ſalt are chiefly theſe. (1.) It makes an effervеſcence with all the known acids, as ſtrong and as durable as fixed alcaline ſalt; cloſely joins the acids with itſelf, and retains it ſo as to form a compound ſalt according to the nature of the acid. And thus, when fully ſaturated, it increaſes $\frac{37}{98}$ in its weight. Whence we may underſtand the requiſite proportion for making the balance betwixt acid and alcali, and how much of either may be again expected upon the reſolution of theſe compound ſalts. But as ſoon as the point of ſaturation is exactly gained, the action of the ſalt, ſo produced, is neither to be eſtimated from the acid or alcali of the compoſition, but from the new nature the compound ſalt has acquired. And hence the error of thoſe may be eaſily confuted, who conceive that the virtues of compound ſalts are ſuch as they obſerve in the parts produced by a ſeparation. (2.) This ſalt, actuated with the heat of the healthy body, preſently inflames, burns, and cauſes a gangrenous eſcar, and therefore perfectly deſtroys all the parts of the human body to which it is ſo applied, as that its motion, ariſing from the heat, may be driven in upon the part. Thus, if a ſcruple of the pure volatile ſalt of hartſhorn be laid upon the ſkin, and covered with a ſticking plaiſter, it will in half a quarter of an hour raiſe a black carbuncle, as if a piece of hot iron had been there applied; and the colour, pain, heat, and hardneſs of the ſkin, are alſo the ſame as they would be in that caſe: and it reſolves the humours into a thin, ſanious liquor. (3.) It is the moſt moveable body of any hitherto known, as exceeding even alcohol in volatility: for if alcohol, water, and this ſalt be put together in a tall chemical glaſs, fitted with an alembic head, and a ſmall degree of heat be applied, the ſalt will riſe by itſelf into the head long before the alcohol; the alcohol will next follow, and the water at laſt with difficulty. And thus this ſalt flies off from every heating point, and if laid upon the warm hand, it preſently flies away without hurting the hand, as in this caſe its reaction is not great upon the heating body; wherein it greatly differs from the fixed alcaline ſalt, which adheres by its weight. But when theſe volatile alcaline ſalts are received into the veſſels of the body, and there actuated by the vital heat, and the force of the circulating fluids, they act very powerfully by a ſharp, ſtimulating, and corroding virtue, eſpecially upon the more ſenſible, fine fibres of the nervous ſyſtem, which they excite to greater motion; and at the ſame time thinning the humours, promote perſpiration, ſweat, urine, and *ſaliva*. They likewiſe frequently prove ſerviceable upon receiving their volatile exhalation, along with the air, into the noſtrils; for thus they irritate the *membrana pituitaria* of the noſe, mouth, jaws, lungs, and, by irritating thereof, diſſolve the viſcous phlegm, that may adhere thereto, provided they be uſed with caution. (4.) Theſe ſalts, therefore, are proper, and have very good effects in aqueous, acid, and auſtere diſtempers of the humours, as alſo in torpidity of the nervous ſyſtem, and diſor-

derly

derly motions of the ſpirits, ruſhing irregularly and involuntarily into particular muſcles. And hence they excellently cure hypochondriacal, hyſterical, epileptical and ſpaſmodical diſorders. Being diluted with water, and received in the form of vapour into the *vagina uteri*, they are eſteemed one of the moſt immediate remedies, when prudently applied, for promoting the menſes if required. But they prove poiſonous in alcaline and putrid diſorders, where the humours are diſſolved, and the body already too much agitated. They may be alſo externally applied, in the way of a cauſtic, for the making of iſſues, the extirpating of warts, and taking off ſtyes upon the eye-lids. The method of uſing this ſalt in theſe caſes, is by laying it upon a little pellet of lint, and applying it to the part; then covering it with a ſticking plaiſter, and leaving it thus, till it may be thought to have performed its office.

PROCESS CXXII.

A ſoap prepared from pure volatile alcaline ſalt, and alcohol.

'TAKE the alcaline ſpirit of ſal-ammoniac, ſo ſtrong as to leave much ' of its ſalt undiſſolved at the bottom; put it into a cold and dry cy- ' lindrical glaſs, with a narrow mouth, ſo as to fill about one half thereof: ' pour to it gradually a quantity of pure cold alcohol, ſo as to run gently ' down the ſides of the veſſel till it be full; a white coagulation will be made ' upon the ſurface where the lighter alcohol reſts upon the alcaline ſpirit. ' If the glaſs be now inverted, there will inſtantly appear a white opake ' coagulation, where the alcohol and alcaline ſpirit mix; and when they are ' both well ſhook together, the whole immediately becomes a white, opake, ' conſiſtent maſs, concreted together like ſtone, ſo that not a drop will fall ' out of the glaſs while inverted. Stop the veſſel cloſe, and ſet it by; thus ' the mixture will ſoon reſolve into a fluid, that floats at top, and a denſe ' ſaline concretion that falls to the bottom; ſo that in a year's time the ſalt ' will almoſt become ſolid below, with a liquor floating above it. If the ' whole maſs, thus produced, be diſtilled with a ſoft fire; an alcaline, bal- ' ſamic, oily, ſolid ſalt will ſublime: and the colder the ſeaſon and the place, ' in which the experiment is made, the better it will ſucceed.'

The uſe.

This is one of the more difficult experiments in chemiſtry, as requiring both the liquors to be perfect, and the obſervance of ſeveral circumſtances, any one whereof being wanting, will cauſe it to miſcarry; but if they all be obſerved, it will always ſucceed. Here we ſee, therefore, that pure volatile, alcaline ſalt, will cloſely attract to itſelf the moſt ſubtile oil that is known, *viz.* alcohol; whence the ſoap, ſo produced, is the moſt ſubtile and penetrating of all ſoaps, as conſiſting of an exceeding ſubtile, and volatile alcali and oil, wonderfully united together in an inſtant. If this medicine be diluted with *Canary*, and taken upon an empty ſtomach, it paſſes, perhaps, thro' all the veſſels of the body, reſolves concretions, opens obſtructions, ex-

cites

cites the vital powers, and thus ſucceſsfully cures many dangerous diſtempers, proceeding from an obſtructing matter, capable of being reſolved thereby. But its virtue vaniſhes too ſoon, as being ſo extremely volatile, and therefore becomes unequal to the more ſtubborn diſtempers. It is highly commended in the jaundice, unattended with an acute inflammation; it does not diſſolve the ſtone, or prevent the concretion or increaſe thereof; it ſeems to agree with ſalt of tartar rendered volatile; it diſſolves in a gentle heat, like ice, and returns to a ſolid form in the cold. If pure alcohol be thus mixed with one third of dry volatile alcali, it makes a much more ſolid ſoap, as being without water, which is always double the quantity in the ſtrongeſt alcaline ſpirit, with reſpect to the pure ſalt. *Helmont* needed not have apprehended the ſudden generation of the ſtone from hence; for this matter is not the ſtone, but diſſolves with heat, dilutes with water, and proves totally and ſpontaneouſly volatile; ſo that it has nothing in common, nor alike to the ſtone. *Helmont* was not the inventor of the experiment, tho' the production be called *offa Helmotiana*, but *Raymond Lully*, long before him; and the *Engliſh* author upon the alcaheſt, ſuppoſed to be *George Starkey*, inconſiderately pretends, that this ſoap brought to a liquor, by repeated diſtillation, will become the *alcaheſt* of *Helmont*.

PROCESS CXXIII.

The aromatic ſimple ſal volatile of angelica.

' 1. TAKE two ounces of the ſlender recent roots of angelica, dug up ' in *February*, and cut ſmall; put them into a glaſs retort; pour ' thereon twelve times their weight of ſpirit of wine, once rectified from its ' watery part; add an ounce of bruiſed ſal-ammoniac, and three drachms of ' ſalt of tartar. Lute on a receiver, and diſtil with a gentle fire, not ex' ceeding a hundred and fifty degrees. There will come over a white, ' alcaline, and alcoholiſed ſalt into the receiver; and when this ceaſes to ' riſe, increaſe the fire a little, and the ſpirit of wine will aſcend in very oily ' veins; continue this fire ſo long as this ſpirit comes over. But when the ' firſt ſalt is wholly diſſolved by the laſt aqueous part that riſes, ſtop the ' operation, and put the liquor into a cloſe glaſs; the remainder may be ' thrown away.

' 2. Put an ounce of freſh root, cut ſmall, into a clean retort, and diſtil ' as before, with the liquor already obtained, and continue till the ſalt begins ' to diſſolve; then ſhake the ſpirit and the ſalt well together, and put them ' into a glaſs that is to be kept well ſtopped, under the title of the ſimple ' aromatic ſal-volatile of angelica.

The uſe.

The alcali of tartar, here drinking in the acid of the ſal-ammoniac, as explained under the hundred and ſixth proceſs, ſets free the alcali of the ſal-ammoniac, which therefore becomes volatile; and uniting with the pure ſpirit of wine, makes the ſal volatile of the preceding proceſs; to which the

prefiding fpirit of the angelica joins itfelf, by mixing with the alcohol; for this fpirit prefides in the balfamic and oily part of the root, and is extremely volatile. And hence, as the nature of alcohol is indeterminate of itfelf, and joins with all fpirits of vegetables alike, it is here determined by the fpirit of angelica, fo as to become the fpirit thereof, according to the fixty-ninth procefs. In the mean time, the volatile and fixed alcaline falts, and the acid fpirit of the fea-falt affift, in the diftillation, to open the body of the angelica, and make it the more eafily part with its fpirit, and its oil thus diffolved. Hence the liquor, thus procured, does by its odour, tafte, penetrability, mobility, faponaceous virtue, and the power it has of correcting what is acid and auftere, afford a remedy of fingular efficacy, in the hands of a prudent phyfician. For it is excellent in all watery, mucous, cold, acid, auftere diftempers, where the efficacy of the bile is wanting, and in all fluggifh diforders unattended with inflammation or putrefaction, efpecially when the diforders, or unequal motions of the nerves and fpirits, occafion troublefome hypochondriacal and hyfterical fits, with the flatulencies thence proceeding. Hence it is at prefent accounted a noble reftorative, ftomachic, warming fudorific, diuretic, diaphoretic, antiparalytic, antifpafmodic, and anti-epileptic medicine, where the diftemper proceeds from the caufes above-mentioned. We are obliged to *Bafil Valentine*, and particularly to *Sylvius*, for introducing this noble kind of medicine; tho' the followers of *Sylvius* often bring it into difgrace by an unfeafonable ufe. Our prefent procefs ferves for a general example; for any other aromatic being fubftituted in the room of angelica, its prefiding fpirit will afford a new remedy, which may be advantageoufly obtained from the flowers of lavender, rofemary, or the like.

PROCESS CXXIV.

The preparation of a compound fal volatile oleofum.

'TAKE twenty-four ounces of the compound fpirit, defcribed under 'the feventy-fecond procefs; put it into a glafs retort, add fix 'drachms of falt of tartar, and two ounces of powdered fal-ammoniac, and 'diftil as in the preceding procefs; there will arife a white, alcaline, fpiri-'tuous, oily falt, which may be kept apart.'

The ufe.

This is another method, and better than the former, of producing aromatic, volatile, oily falts for medicinal ufe. It may be eafily underftood from what is above delivered under the fixty-ninth, feventieth, feventy-firft, feventy-fecond, the hundred and fixth, and the hundred and twenty-third proceffes; for the fpirits here kindly uniting, they afford noble remedies, if cautioufly and feafonably ufed, and may be varied infinite ways at every one's difcretion.

PROCESS CXXV.

A particular preparation of sal volatile oleosum.

'THIS title promises a remedy of some peculiar virtue, directed to 'a certain medicinal end: for example, if a volatile salt be required 'for bringing away the birth, the *lochia*, &c. take the distilled oils of 'juniper, rue, savine, and *arbor vitæ*, of each two drachms; dissolve them 'in twenty ounces of alcalised alcohol, according to the sixty-seventh pro- 'cess, into a quintescence, to which add two ounces of pure, dry, volatile, 'alcaline salt, and shake them well together; they will thus unite tolerably, 'provided the salt were sufficiently dry, and thus the medicine required is 'obtained.

The use.

This is a third method, and no bad one, of procuring a *sal volatile oleosum*; and if it be previously known from botany and medicine, what the virtue of every plant is, so that chemistry may be certain that their particular virtue resides in their oils, then we can by this method prepare such salts for particular purposes. Thus, cephalic salts may be obtained with the oils of lavender, rosemary, and marjoram; cardiac salts, with the oil of the peel of orange, citron, lemon, cinnamon, nutmeg, and so of the rest.

PROCESS CXXVI.

An extemporaneous sal volatile oleosum.

'1. TAKE one part of salt of tartar, three parts of sal-ammoniac, 'twelve parts of aromatics, reduced to powder, and twenty-six parts 'of rectified spirit of wine; mix them together, by long shaking in a bolt- 'head. The alcaline salt will thus immediately unite with the alcohol that 'floats above, the water being attracted into the salts; at the same time 'the salts and spirits will attract the oil out of the spices, and thus the li- 'quor, that floats above, will presently become the *sal volatile* required; as 'the famous *le Mort* has observed.

'2. Or, take three parts of salt of tartar, and nine of sal-ammoniac; 'put them into a glass-body along with one part of any distilled aromatic 'oil; and directly sublime into a large head, with a gentle fire, barely suf- 'ficient to raise the salt; keep the fire in this degree so long as any salt sub- 'limes, then have ready a clean, dry, and cold glass, close fitted with a 'glass-stopper; and now taking off the head, break off the salt with a 'bent iron rod upon a paper, or glazed dish; then bruising it a little, pre- 'sently put it into a store-glass for use. This is a saponaceous, volatile, 'oily salt, according to the nature of the oil employed, and of frequent 'use in *England* against hysteric fits, *&c.*

The use.

Thus we have gone thro' the various ways of preparing these volatile oily salts, which are nearly related, as their virtue depends upon a volatile soap, united with alcohol, and the presiding spirit of vegetables. The practice of physic throughout *Europe*, turned chiefly upon the use hereof, after the famous *Sylvius* published his *praxis medica* in the year 1671, *Otto Tachenius*, his little treatise *de morborum principe*, and *Bontekoe* his works. But in inflammatory distempers, where the juices are dissolved and putrid, in the alcaline scurvy, the phthisic, consumptions, and other cases, where the body is almost dissolved down, they often prove highly pernicious, and sometimes destructive. Physicians, therefore, are to be seriously admonished against permitting men, and, particularly, women of a weak constitution, the frequent use of these salts in the way of smelling-bottles, whereby the olfactory nerves, and others are spoiled, and the fine arteries of the nose and lungs easily disposed to hæmorrhages, which are always dangerous, and sometimes mortal.

And thus I hope to have shewn the true chemical analysis of the parts of animals; and again, the method of combining these separated parts into various forms, for chemical and medicinal use; whence it appears, that by putrefaction, and the distillation of putrefied and crude substances, there may be obtained, (1.) A certain, somewhat fetid, volatile and thin spirit, mixed with water, and difficultly separated from it. (2.) A water, nearly approaching to elementary, excepting only that it can scarce ever be separated from its spirit. (3.) An alcaline, volatile salt. (4.) A thin volatile oil. (5.) A thicker oil. (6.) An earth, in all cases the same. (7.) Phosphorus, containing a strong ponderous acid. (8.) Sea-salt, when this has been used in the meat or drink, otherwise not. It next appears, that these productions, however depurated, separated, and brought to their utmost perfection, cannot by any art be compounded, so as to exhibit their original form and virtues; but are changed into a new body, which has scarce its like in nature. What wonder, therefore, if all the parts of animals become volatile by putrefaction, and either go off into the air, or sink into the pores of the earth, whilst what was thus carried off, into the air, is again returned, and mixed with the earth in rain, mist, dew, hail, and snow? What wonder, therefore, if the principles of vegetables should hence arise, that are convertible, by a seminal power, into their former nature, and thus enrich the exhausted earth for supplying food to animals, by whose vital powers they are converted into the substance of their bodies? Certainly, so much as the earth loses by feeding plants and animals, it again receives from them upon their destruction and putrefaction.

PROCESS CXXVII.

The phænomena of the blood and ſerum, from the action of the air, water, fire, ſalts, acids, alcalies, ſpirits, oils, and ſoaps thereon.

'1. HEALTHY blood concretes into a cake in air, heated from thirty-'two to ninety-four degrees; it ſeparates into ſerum and a red 'coagulum; it again reſolves, becomes liquid, putrefied, and volatile, and 'at length goes off into the air, except a ſmall fixed part. In air that 'grows cold, from thirty-two degrees of heat to one, and lower, it concretes 'ſooner, freezes, and thereby ſeparates its water from the other principles, 'which are drove into one maſs apart. While it remains thus frozen, the 'water is ſoon diſſipated from it, and continually diminiſhes ſurpriſingly: 'the remainder being thawed, preſently reſolves into a corrupt liquor, that 'putrefies, becomes extremely volatile, and thus readily flies off into the 'air. In an air heated to a hundred and twenty degrees, which is never 'found in the atmoſphere, it preſently begins to coagulate into a concreted 'maſs, and ſo up to two hundred and fourteen degrees, but afterwards 'reſolves with a greater heat. It admits the air equably divided among its 'particles, but this only in a certain proportion; and to endeavour, by 'ſhaking, to mix more with it, is in vain; for the air is either repelled, or 'entangled, and ſeparated into bubbles.

'2. It firſt dilutes in water, heated from thirty-two to ninety-four de-'grees, but ſoon after coagulates. It alſo coagulates with a boiling heat, 'and therefore cannot be kept fluid by water, without the grinding motion 'of circulation; neither can bare motion, or briſk ſhaking, preſerve its 'fluidity, or reſolve it when coagulated out of the veſſels of the body, not 'even tho' this be done in water, as the famous *Ruyſch* found by a particu-'lar experiment, but it concretes into a viſcous maſs. It putrefies in wa-'ter, if expoſed to the air; whence it is not true, that cold or warm water 'dilutes the blood, but ſpring-water ſeems to coagulate it more than rain-'water.

'3. The degrees of fire, from thirty to a hundred, putrefy, reſolve, 'ſeparate, and volatilize the blood: a greater heat coagulates it, up to two 'hundred and twenty degrees; but a greater than this again reſolves, and 'ſuddenly putrefies it.

'4. The acids of *Moſelle* and *Rheniſh* wine, vinegar, and diſtilled vine-'gar, dilute the blood, ſcarce alter its colour, and in ſome meaſure pre-'vent its coagulating. The acid of nitre inſtantly coagulates it, and 'turns its colour bluiſh; the acid of ſea-ſalt likewiſe ſoon coagulates it, 'and changes it of a grey colour, inclinable to black: the acid ſpirits of 'vitriol and ſulphur alſo bring it to a firm maſs, which is generally 'whitiſh.

'5. Volatile

'5. Volatile alcali fcarce coagulates it, but preferves it red. Fixed alcali rather diffolves, than coagulates it: *Sal volatile oleofum*, in fome meafure, coagulates it: fal-ammoniac, nitre, fea-falt, fal-gem, and borax, heighten and preferve its colour, and fomewhat prevent its coagulating; fo likewife do the common and philofophical foaps. Alcohol coagulates it; oils make it more vifcous. In all thefe experiments there is no fign of effervefcence, or ebullition; but the colour and confiftence are the principal things which we here find to be changed. Regenerated tartar, well prepared, preferves, or heightens the colour of the blood, and excellently preferves its fluidity: the liquor of tartarifed tartar does the fame; and *Venice* foap has nearly the fame effect. But *Helmont*'s tincture of falt of tartar, in refpect of the alcohol, whofe quantity is large, rather coagulates it; tho' in refpect of the other ingredients, the effect is lefs fudden. The beft *fal volatile oleofum*, undiluted, rather fomewhat thickens the blood, on account of the alcohol. The compound liquor of the fpirit of vinegar, and volatile falt, made according to the hundred and eighth procefs, excellently attenuates and dilutes the blood, and preferves its natural colour.

'6. Metals, diffolved by acids, and thus made into a compound falt, and afterwards diffolved in water, fo as fully to faturate it, wonderfully and fuddenly change both the colour and confiftence of blood; fuch as the folution of the vitriol of iron, which coagulates the blood, and turns it almoft black; fo does the folution of lead with vinegar, or fpirit of nitre: mercury-fublimate alfo has almoft the fame effect: and the oil of quickfilver, which I prepare with the ftrongeft oil of vitriol and quickfilver, has the fame effect in a very ftrong and fudden manner. Whereas thefe mercuries, when given in a fmall dofe, foon and with certainty diffolve down all the blood into a thin, fluid, cadaverous water, that quickly paffes, and fweats out, at all the emunctories of the body.'

The ufe.

Hence we learn, in fome meafure, the fenfible effects wrought upon the blood, by the admixture of certain known bodies, which being injected into the veins, produce the like effects in the living body, by bare mixture. But the fame things, when taken at the mouth, often produce very different effects. And there are bodies, which being mixed in an incredibly fmall quantity, produce the greateft changes, without any fenfible alteration of the fluids, as we fee particularly in poifons. Therefore we muft not always conclude, that the efficacy of mixture will be the fame in the body, as out of it, whilft the blood being extravafated is contained in glaffes. It alfo appears, that all mild things, rather than fharp ones, dilute and diffolve the animal fluids. Hence we fee there can be no effervefcences in the vital blood, contained in its proper veffels, and by no means fuch as can have a force equal to the removing of great obftacles, and producing very fwift motions. *Paracelfus*, therefore, *Helmont*, *Defcartes*, *Sylvius*,

Sylvius, and others, in vain took up this hypothesis, to explain the actions of the body. Hence appears the fatal error of those physicians, who, after having unjustly condemned acids, under the false notion of their coagulating the blood, by an argument wholly derived from milk; whilst *Hippocrates*, from a closer observation of nature, judged that vinegar was proper in inflammatory distempers, tho' the blood is thence rendered more dense. And we cannot safely pronounce concerning the effects of acids upon the blood, unless it be first distinctly explained what kind of acid is understood: the use of mineral acids is dangerous, but of vegetable acids more wholesom; and it frequently happens, that the things which really coagulate the blood are supposed to dissolve it.

PART III.

Chemical Operations upon MINERALS.

I.

PROCESSES *upon SALTS.*

PROCESS CXXVIII.

The examination of nitre.

IN the chemical treatment of minerals, we are firſt to begin upon ſalts; theſe being generally required in the preparations of other foſſils. And becauſe among foſſil ſalts, nitre, in its origin, nearly approaches to animals and vegetables, this muſt firſt be treated on, as being a kind of dubious thing among the three, and appearing to proceed from putrefied animals (that do not uſe ſea-ſalt) mix'd with alcali and lime; but of this we have ſufficiently treated in the ſecond part. It does not ſeem to be the *nitrum*, or *litrum* of the ancients.

'1. Put nitre into a clean crucible, and fuſe it with a gentle fire, without 'fulmination; it remains melted like pure water, without changing its na-'ture, and ſcarce loſing any thing by exhalation. It paſſes thro' the cru-'cible, but does not grow alcaline, or become ſharper; and when poured 'out, it preſently becomes ſolid, and never when, thus melted, takes flame, 'nor ignites; whence it is falſely called an inflammable ſalt. And yet 'whilſt it remains thus fuſed, if any combuſtible matter be thrown into it, 'it immediately takes flame, whence it came to be called inflammable; but 'when taken internally, it cools the body more than any other ſalt.

'2. Put a ſolution of the pureſt nitre, made with water, into ſeparate 'glaſs veſſels, and pour ſucceſſively to them different acids; and the liquors 'will be found to make no ebullition, nor to grow warm, opake, or troubled. 'To another parcel of the ſame pour pure oil of tartar *per deliquium*, where-'upon the liquor will grow opake and muddy, and ſoon depoſite a large 'ſediment at the bottom; from whence the liquor being decanted, it will 'no longer grow troubled by the addition of freſh alcali: and nearly the 'ſame thing happens upon the addition of volatile alcali. And this is the 'true nature of nitre.'

The uſe.

Hence it appears that nitre is neither alcaline, nor acid, nor of itſelf inflammable; but of all ſalts the eaſieſt fuſed in the fire.

PROCESS

PROCESS CXXIX.

The refinement and cryſtallization of nitre.

'1. DISSOLVE common nitre in ſix times its quantity of boiling
' water, ſtrain the hot lixivium quick, put it into a clean cylindri-
' cal veſſel, and exhale it over a clear fire, to a pellicule; ſet it in a cool
' place, with clean ſticks acroſs the veſſel: there will preſently be formed long
' priſmatic, hexagonal, tranſparent cryſtals. Collect theſe, and put them
' into an earthen colander, that the liquor may drain from them; afterwards
' dry the nitre in the open air.

'2. Diſſolve nitre in eight times its quantity of boiling water, filter the
' lixivium, then drop therein ſome pure oil of tartar; mix them well,
' then drop in more, and continue to do thus, till the liquor appears no
' more diſturbed. Boil the lixivium for a ſingle minute, ſtrain it hot to
' make it perfectly clear; exhale to a pellicule; pour it out into a clean cy-
' lyndrical veſſel, with little ſticks laid acroſs, and let it ſtand in a quiet
' place: priſmatic cryſtals, like the former, will thus be formed. No ex-
' periment ſhews, that any alcali here adheres to the cryſtals of nitre,
' which is thus made pure; nor does it appear that any method can afford
' it purer.

'3. Let the lixivium, that remains after this firſt cryſtallization, be diluted
' with an equal quantity of fair water, then boiled for a moment, filtred hot,
' inſpiſſated to a pellicule, and ſet in a cold place, as before; it will thus ſhoot
' into cryſtals of pure nitre, which are to be dried as above. The remain-
' ing lixivium being again treated in the ſame manner, and again ſet to
' cryſtallize, yields more of them. And now the remaining liquor, which
' is fat and ſharp, will afford no more cryſtals, and dries with great diffi-
' culty; and this happens not only when alcali has been uſed in the refining,
' but alſo when nothing but pure nitre was added. This laſt remainder is
' a peculiar and very ſaline fluid, that long remains fixed in the fire.

The uſe.

1. By this means an excellent nitre is procured for medicinal uſe; being very light, of a particular bitteriſh taſte; and when taken into the body, it eaſily diſſolves therein, wonderfully cools and thins the blood, giving a florid colour thereto, and checking the inclinations to venery. It is changed in the body, not being unalterable therein like ſea-ſalt, but turning into the human ſalt, as explained in our proceſſes upon urine. If the moiſt, or ſolid parts of animals be ſalted with this nitre, they are thereby kept extremely red, and free from putrefaction; whence in all inflammatory diſtempers, attended with an inflammatory condenſation of the blood, this ſalt proves excellently attenuating, and at the ſame time no way offends by any violent acrimony, nor proves prejudicial by its weight. It does not occaſion thirſt, and prevents the ſalt of the body from turning alcaline, and the oil from putrefying: and on this account it may properly be called an antiphlogiſtic ſalt.

2. Here we ſee an example of that operation uſually called the cryſtallization of ſalts, which is a collection of ſaline principles of the ſame ſpecies, into particular glebes, or ſhoots, always of the ſame figure, and peculiar to each particular ſalt. This depuration depends upon that law of nature, whereby the parts of different ſalts being diluted in water, and brought to a certain proportion in reſpect of the water, begin to acquire a faculty of uniting their own particular parts together, more than of uniting with the water, or any other ſalts, whence they repel both the water and other ſalts. And thus thoſe ſalts always begin to come firſt together, when ſeveral kinds are mixed, which require moſt water to keep them diſſolved; for thus theſe aſſociate firſt, and repel from them the other ſaline parts, that remain fluid in leſs water; ſo that if any ſalts could be reſolved in one and the ſame proportion of water, it would be extremely difficult to ſeparate and diſtinguiſh them; which is now eaſily and certainly performed. And thus nitre is perfectly ſeparated from ſea-ſalt, and ſea-ſalt from ſalt of tartar. For when nitre is thoroughly purified from ſea-ſalt by cryſtallization, it affords an acid ſpirit by diſtillation, which diſſolves ſilver, but will not touch gold: whereas, if a little ſea-ſalt remained with the nitre, it would afford an *aqua regia*, not an *aqua fortis*. The ſame nitre being diſſolved in water, and purified with the addition of fixed alcali, does, by the bare cryſtallization, throw off all the alcali; for, in diſtillation, it is converted into an acid ſpirit, which would not be ſuch, if any fixed alcali adhered to the nitre. Whence we may obſerve a wonderful attractive, and repelling power, in this action of cryſtallization.

3. If theſe cryſtals are well prepared, they always appear tranſparent, and of their own exact particular figure; and ſo long as they appear thus, they always conſiſt of the ſalt and water united in a certain method and proportion. This appears from hence, that if theſe cryſtals be put into a clean glaſs, covered with an alembic-head, and heated by the fire, they yield a pure water; but at the ſame time preſently grow white, opake, and loſing their figure, fall into a powder of no particular figure. But if this powder be again diſſolved in water, inſpiſſated, and cryſtallized, the ſame form and tranſparency return. Whence this ought to be conſidered by thoſe who write about the figure of the ſaline principle. Nitre, thus purified, remains dry in the air, and does not eaſily run by the moiſture thereof.

PROCESS CXXX.

Nitre changed to alcali, with tartar and fire.

'TAKE ſix ounces of pure dry nitre, reduced to powder, and the ' ſame quantity of pure, dry, and pulverized cream of tartar; mix ' them together in a mortar, and again, dry the powder thoroughly; put ' an ounce of this powder into a clean and dry bell-metal mortar, firſt well ' heated, and apply thereto a little bit of burning coal: the whole mixture ' will thus inſtantly deflagrate, with a violent noiſe, ſcattering many ſparks ' abroad, and diſperſing a ſtrong-ſmelling fume; and leaving behind a white ' maſs,

'mass, somewhat greenish in several parts. As soon as the deflagration is 'over, throw half an ounce of the same powder upon the burning mass, 'and this also will deflagrate as the former, but quicker, because of the 'greater heat. Continue thus, till the whole mass is deflagrated, and leaves 'behind a white, greenish, uniform mass, except a few small parts up and 'down, which have not sufficiently felt the fire. These, therefore, should 'be carefully separated from the rest of the mass; and hence it would be 'better if only a small quantity were deflagrated at once, because the fire 'would be thus more equably applied thereto.'

The use.

Hence it appears that nitre, which of itself is not inflammable, according to the hundred and twenty-eighth process, yet being mixed with tartar, which is oily, according to the fifty fifth, it immediately takes fire, with a violent agitation, like gunpowder, upon the application of a live-coal; and that the manifestly acid salt, made by a mixture of nitre and tartar, is at once by a single, sudden, inflaming action of the fire, turned into alcali, of which, a little before, there appeared no sign, either in the nitre or the tartar. Nor is there hitherto known any method so sudden, of producing a strong fixed alcali, from a mixture of salts that are not alcaline, but on the contrary giving manifest signs of a predominating acid. For the salt thus produced is a sharp, fixed, and strong alcali, in all its effects, and almost in every chemical, medicinal, and physical operation. It however differs somewhat from other fixed alcalies, as yielding, when oil of vitriol is poured upon it, a certain acid spirit, that plainly appears, by its scent, to be spirit of nitre; which shews that some true nitre still remains in this alcali, according to the hundred and thirty-fourth process, now soon to follow; but the quantity of this acid is small. We have here, therefore, an excellent method of expeditiously preparing a fixed alcali, whenever it is wanted; and this sudden change of nitre into alcali will not appear strange to him who knows that no nitre is obtained in *Europe*, without the assistance of fixed salt, which is found in the ashes of burnt wood. Lastly, the salt, thus prepared, readily runs in the air.

PROCESS CXXXI.

Nitre turned to an alcali with live-coals.

'FILL a strong and large crucible with very dry powdered nitre, laid 'in light; set the crucible firm in the furnace, and surround it with 'burning coals at a distance, then gradually bring them nearer, that the 'crucible, with the nitre it contains, may be thus heated equably, to pre-'vent bursting. When all is now thoroughly hot, apply as strong a fire 'as is necessary to make the nitre run like water; then take a little piece of 'wood-coal, thoroughly ignited, and put it gently into the melted nitre, 'now at rest. The coal (not the nitre) will thus instantly take flame with 'a hissing noise, and move over the whole surface of the melted nitre with

'a brisk motion, till it is consumed, and the flame extinguished, so as to leave the nitre melted, as before it was thrown in. Now throw in another bit of live-coal as before, and the same phænomena ensue; continue repeating the operation, till at length the nitre remains fixed with the same degree of fire, so as to flow no longer, nor give flame to the coal thrown in, which at length will always prove the case. This state may be known to approach, when the nitre begins to lose its fluidity, and the coal leaps briskly about, and sometimes flies out of the crucible: at this time, therefore, the fire should be a little increased. When the coal ceases to flame any longer, let all cool, and there will remain in the crucible a mass, with an hollow part on its top, where the last burning coal had rested: this mass is solid, ponderous, of a colour betwixt white and green, fiery, alcaline, and presently runs in the air; therefore, whilst yet very hot, let it be presently taken out by breaking the crucible, and put into a clean glass, to be carefully stopped.'

The use.

1. Here the eye perceives that nitre will not take flame with a burning coal; and that between the inflammable matter of the coal, and the melted nitre, there arises a great motion of impulse and repulse: for when the live-coal, that flew about in the crucible, is consumed, the nitre immediately remains without any visible motion, and does not appear on flame till, by the addition of a fresh coal, the same motion is renewed; and therefore the consumption of the coal is hastened by the melted nitre, whilst it would otherwise consume much slower; and this accelerating action of the fire, upon the combustible matter, seems to increase the deflagration; and, therefore, that the effect of nitre upon combustible bodies, by means of fire, is no more than this violent repulsive motion, whereby the coal, if somewhat large, is driven from the nitre with an explosive force; after which the whole nitre remains calm and at rest.

2. The ashes of the fixed vegetable coal, after the deflagration, here turn into a fixed alcali, that very easily relents in the air; but this alcali, here produced, is much larger than would be afforded by the burnt vegetable matter, and must also proceed from the changed nitre. This is another method of converting nitre into alcali: the alcali, thus produced, is very difficult to keep dry; but presently relents in the air, and runs into a strong fiery alcaline liquor, leaving a large quantity of ashes behind. But if the salt, as soon as prepared, be dissolved in rain-water, and directly strained, and the fæces remaining in the strainer be washed so long, in changes of water, till they retain no salt, they now become insipid, when dried. And if the several solutions be evaporated to the consistence of the oil of tartar *per deliquium*, a liquor like that will be obtained. And these pure ashes, being weighed, will shew how much of each remained after the deflagration; and consequently how much salt of the burnt vegetable-coal might contribute to the making of this alcali: and hence also may be known, how much the nitre contributed to its production. This preparation is commonly called alcalized or fixed nitre.

PROCESS

PROCESS CXXXII.

Sal prunellæ from nitre.

' 1. TAKE nitre, purified according to the hundred and twenty-ninth ' procefs, melt it at the fire in a clean crucible, and as foon as ' melted, pour it out in cakes upon a clean marble, and keep them, under ' the title of *fal prunellæ*, for medicinal ufe.

' 2. Diffolve this nitre in clear rain-water, wherein red poppy flowers ' have firft been infufed warm, fo as to give a beautiful tincture, which is ' to be filtered; infpiffate the folution, and let it fhoot into cryftals, in the ' common method: thefe being dried are another kind of *fal prunellæ*, or ' cryftal mineral, formerly held a fecret, as an infallible antiphlogiftic.

' 3. Melt four ounces of pure nitre in a clean crucible, and throw a fcru- ' ple of the flowers of fulphur thereon, there will inftantly arife a great ' flame, like lightening, which, when the fulphur is entirely confumed, ' directly goes out of itfelf. And this being three or four times repeated, ' and the nitre poured out into moulds, fo as to form little cakes, is another ' medicated *fal prunellæ*.

The ufe.

The nitre thus prepared entirely agrees, in virtue and ufe, with that of the hundred and twenty-ninth procefs; which I rather prefer, as the trouble of the prefent procefs feems unneceffary; and refined nitre every way anfwers the purpofe. But hence we fee that melted nitre, tho' perfectly at reft in the fire, has the fame effect upon inflammable fulphur as it before had on the ignited coal; that is, to make it deflagrate quicker and ftronger: and hence the difcovery of gunpowder, which is prepared from nitre, fulphur, and coal. This prefent preparation has obtained the name of *fal prunellæ* from the *Germans*, who obferving that a certain kind of epidemical camp-fever, attended with a dangerous black quinfey, which they call *die braune*, was happily cured by the ufe of this powder; they thence called it by that name: and for the fame reafon they give the fame appellation to the plant felf-heal, or *prunella*; becaufe this cures the fame diftemper. The falt, thus prepared, is never alcaline.

PROCESS CXXXIII.

Sal polychreftus.

' 1. MELT pure nitre in a crucible, and throw a little pure fulphur ' thereon, not exceeding a fcruple at a time; it will deflagrate, ' as in the preceding procefs; continue throwing on the fame quantity after ' each deflagration, till at length as much fulphur is ufed as there was nitre: ' towards the end of the operation, the fulphur thrown in does not flame ' fo violently, nor fo brightly as before. Keep the crucible ftill in the fire,

' in

‘ in the ſtate of ignition, for an hour; the ſalt will appear reddiſh up and ‘ down, but otherwiſe of a grey colour; if immediately after the deflagra‘ tion with an equal quantity of ſulphur, the ſalt be taken out without any ‘ farther application of fire, it has always appeared to me, upon examination, ‘ to have perfectly the ſame efficacy as the former. 2. Or take equal parts ‘ of pure dry nitre, and flowers of ſulphur, grind them to fine powder, and ‘ heat it carefully; then throw two ſcruples thereof at once into an ignited ‘ crucible, whilſt it remains in the fire: a violent deflagration will immedi‘ ately ariſe; which being over, throw the like quantity to the remainder, ‘ and this will deflagrate as the former. Continue thus till all the powder ‘ is thrown in; there will now remain at the bottom of the crucible a ſalt ‘ extremely like the former. 3. Diſſolve the ſalt, thus prepared, in five ‘ times its quantity of hot water, in a glaſs-veſſel; ſtrain it, whilſt it is ‘ hot; inſpiſſate it to drineſs; it will be of a white colour, of a bitteriſh ſul‘ phureous warm taſte, and of the ſame nature with the ſalt ſometimes found ‘ in hot mineral waters; it is neither acid, nor alcali, but conſiſting of nitre, ‘ and ſome proportion of ſulphur, changed by the fire.

The uſe.

Sulphur, therefore, which conſiſts of the acid of vitriol and oil united together, has here the greateſt part of its oil conſumed in the flame with the nitre; and its acid part, now, perhaps, ſomewhat changed by the fire, along with ſome part of its oil, intimately mixed amongſt the nitre, now alſo changed by the ſame, ſo as to produce a neutral foſſil ſalt in the fire. Whence we ſee that nitre, which, when fired with a vegetable coal, turned into fixed alcali, is here, with ſulphur, changed into a fixed ſalt, that is not alcaline, tho' it had ſo long and ſo ſtrongly been deflagrated with ſulphur. Phyſicians, eſpecially thoſe of *Paris*, having thoroughly experienced the virtues of this ſalt, called it *polychreſtus*, becauſe of its various effects, and proving ſucceſsful in many different diſeaſes. If taken upon an empty ſtomach, by a perſon in health, in the quantity of two drachms, diluted with twenty times its quantity of water, the perſon walking gently after it, and drinking four or ſix ounces of new whey, for three or four times, it ſometimes proves gently vomiting, oftner purgative; but always diuretic and ſudorific, ſo often as it is determined to operate that way, by heat, motion, and ſudorifics. It cuts cold viſcous phlegm, reſolves in denſe inflammations of the blood, opens the paſſages, corrects the bile when tending to putrefaction, excites it when languid, and ſtimulates it with gentleneſs and ſafety. Hence, being prudently given in chronical and acute diſtempers, it proves curative. It almoſt certainly cures inveterate tertians, without any danger of relapſe, or without obſtructing the *viſcera*. It ſecurely cures quartans, by gradually reſolving the ſluggiſh matter thereof; and therefore has deſervedly obtained the name of the ſalt of many virtues. If a little ſal-ammoniac be thrown into melted nitre, it takes fire: and if ſaturated by repeated addition, it affords a wonderful ſalt, that deſerves to be examined, on account of its particular nature.

PROCESS

PROCESS CXXXIV.

Glauber's *ſpirit of nitre.*

'PUT eighteen ounces of pure dry nitre, reduced to an impalpable pow- ' der, into a clean glaſs retort, and pour thereon ſix ounces of pure, ' and highly rectified oil of vitriol : immediately place the retort in a ſand- ' furnace, and apply a large glaſs receiver ; luting the juncture with a mix- ' ture of lime-clay and a little ſand. There will preſently ariſe a heat, and ' a red fume ; apply a moderate fire, and the receiver will ſoon be full of ' red fumes, and a liquor begin to drop gradually. Increaſe the fire to the ' utmoſt that ſand will give ; and then let all ſpontaneouſly cool. As ſoon ' as the neck of the retort is a little cold, ſeparate the receiver, and have ' at hand a ſtrong dry glaſs, with a narrow neck, fitted with a ſlender fun- ' nel ; pour the liquor into a bottle, thro' the funnel, under a chimney, to ' prevent the red fume from any way coming to the lungs, for it is ſharp, ' fiery, incredibly volatile and diffuſive ; as ſoon as the ſpirit is in, exactly ' ſtop the mouth of the containing glaſs with a glaſs-ſtopper : in like man- ' ner, ſtop the receiver, and ſet it by for the ſame uſe ; it will remain for many ' weeks filled, with a red vapour, in continual motion. The liquor, in the ' glaſs will appear of a gold-colour, with a red vapour always appearing in ' the empty part above, even for years, as I have found by experience : ' and if at any time opened, a volatile copious, red vapour immediately ' flies out. The operation is beſt performed in the cold winter-ſeaſon.

The uſe.

Oil of vitriol can ſcarce touch nitre, but there immediately ariſes a violently acid, ſharp, fiery, volatile ſpirit, that is perfectly nitrous, and has all the ſame effects as common *aqua fortis*, and with fixed alcali returns to true nitre again. It is impoſſible to obtain more ſpirit from this nitre, by the addition of leſs or more oil of vitriol, whatever degree of a ſand-heat be uſed. All the nitre, therefore, is not changed from fixed to volatile, from ſolid to fluid, from mild to ſharp, from white to red, from neutral to acid, and from unactive to a moveable reſtleſs liquor. This liquor is the true ſpirit of nitre, as appears by its ſmell, taſte, colour, red fumes, effects, and its power of regenerating nitre again. It contains nothing of the oil of vitriol employed, as appears from certain experiments : the other part of the nitre, therefore, which is not rendered volatile by this operation, unites with the oil of vitriol, fixes therewith, and becomes a white denſe ſalt, neither acid nor alcaline, but neutral, and of a new kind, ſomewhat reſembling the *tartarum vitriolatum.* Upon conſidering this, ſome eminent chemiſts have ſuppoſed, that nitre, in its origin, was made of a fixed alcaline ſalt, and the proper ſpirit of nitre, ſuch as is here produced ; and mixed together to a perfect ſaturation. But as oil of vitriol is a much ſtronger acid than ſpirit of nitre ; when that comes to be mixed with the nitre, they imagine that the fixed alcaline part of the nitre attracts the acid oil of vitriol, ſo that the two here

here unite into a ſalt, conſiſting of the alcali of nitre, and the oil of vitriol, whilſt the pure acid of the nitre, now ſet free, by the oil of vitriol, from the alcali, that detained it before, remains a pure, red, volatile acid, of its own peculiar nature. Hence they attribute this whole action to the bare ſeparation of the parts pre-exiſting in this form before, and not produced afreſh by the action of the fire. This explanation ſeems very plauſible, and countenanced by other experiments; particularly, hereafter, in the hundred and thirty-ſixth, the hundred and thirty-ſeventh, the hundred and forty-third, the hundred and forty-fifth, the hundred and forty-ſixth, and the hundred and forty-ſeventh proceſſes. But if we conſider the origin of nitre from animals and fixed alcali, it ſeems difficult to find a principle in them, any way reſembling ſuch an acid ſpirit, as is here prepared; eſpecially, ſince the moſt diligent enquirers into nature cannot find any perfect nitre, ſpontaneouſly generated. Certainly, there is no inſtance of any natural acid like that here obtained; we muſt therefore abide by our experiments, and beware of haſty concluſions. There is no known method, either of art or nature, for obtaining a ſtronger, or a purer ſpirit of nitre than this; whence we ſhall always uſe this ſpirit for the future in thoſe operations that require it. *Glauber* was the firſt who diſcovered this art, which he held as a ſecret, and ſold the production at an extraordinary price, but at length divulged the method; to him we are therefore obliged for ſo excellent an invention. And hence we have an intimation what numbers of new, uſeful, and excellent diſcoveries might be made, by applying one body to another, and afterwards working upon them with fire. The preſent experiment is one of the nobleſt that chemiſtry ever produced.

PROCESS CXXXV.

Glauber's *dulcified ſpirit of nitre.*

' 1. PUT into a tall bolt-head eight parts of pure alcohol, prepared ' without alcali, let fall into it only a few drops at once of *Glauber*'s ' ſtrong ſpirit of nitre; then leave off, and ſhake the two liquors well toge- ' ther, that they may perfectly mix; afterwards drop in more, ſhake as be- ' fore, and thus proceed carefully, till an eighth part of the ſpirit of nitre ' be added, in proportion to the alcohol; obſerving after each time to ſhake ' the glaſs thoroughly. Afterwards digeſt the liquor for ſome time; and ' then diſtil it twice or thrice over in a retort: thus a true dulcified ſpirit of ' nitre will be obtained (*a*). 2. If common ſpirit of nitre, and common ſpirit ' of wine, were here uſed, they would not thus afford ſo noble and balſamic ' a ſpirit, on account of the water they each of them contain. 3. I have ' often experienced, and ſhewn the dangerous effects that may ariſe upon ' mixing large quantities of alcohol and ſtrong ſpirit of nitre together; for if ' to two drachms of *Glauber*'s ſpirit of nitre, contained in a bolt-head, there ' be at once added ſix or ſeven drachms of alcohol, there will ariſe a violent

(*a*) See *Hoffman. Obſervat. Phyſic. Chym.* p. 128.

' heat,

'heat, ebullition, and vapour; and all the liquor fuddenly efcape out of 'the glafs, tho' it were ever fo high, and this with great danger of fuffo-'cation, if it fhould touch the lungs; and in this manner I have loft both 'the liquors. The excellent Doctor *Slare* has more obfervations to the 'fame purpofe (*a*).

The ufe.

Upon thus mixing together alcohol and fpirit of nitre, there immediately arifes a fragrant fmell, like that of fouthern-wood; there is alfo obferved a high degree of effervefcence betwixt this volatile acid and pure fubtile oil, without the leaft interpofition of an alcali. And yet the effervefcence is almoft fiery; fo that if a lighted candle were applied to the vapour, the infide of the glafs would appear on flame, and the whole inftantly burft in a dangerous manner. The oftner thefe two liquors are digefted, and diftilled together, the more exactly they unite, and thus afford a perfectly acid and oily falt, which has an actual prefervative, balfamic, detergent, diffolving virtue, and prevents the putrefaction of the bile. Being properly diluted, and prudently ufed, it prefently gives a beautiful whitenefs to the teeth; but if imprudently ufed, deftroys them. It reftores the appetite, if depraved by a mucous phlegm, or corrupt bile, or if the caufe proceeds from a weaknefs of the ftomach. It is a great carminative; it is recommended as a prefervative againft the ftone, and even as a folvent for it. It was formerly the famous lithontriptic of *Sylvius*, held at fo dear a price. It promotes fweat, provokes urine, allays thirft, corrects a fetid breath, and has particular virtues in the fcurvy. It is conveniently taken upon an empty ftomach, to twenty or thirty drops in wine, mead, or beer.

PROCESS CXXXVI.

The regeneration of nitre, by means of the hundred and thirtieth, hundred and thirty-firft, and hundred and thirty-fourth proceffes.

'1. TAKE an ounce of dry fixed nitre, made according to the hundred and thirtieth, or hundred and thirty-firft procefs; diffolve 'it in eight times its quantity of fair water, and filter the folution. Pour 'the liquor hot into a clean, heated, large glafs, with a narrow neck; 'drop thereto, fucceffively, a few drops of *Glauber*'s ftrong fpirit of nitre: 'the falling in of each drop fuddenly occafions a great effervefcence; fhake 'the glafs fo long as this continues, then drop in more, as before, and con-'tinue thus, till the effervefcence begins to abate; after which add only 'a fingle drop at a time, and ftrongly fhake the hot liquor. Proceed thus, 'carefully, till no more effervefcence appears; the liquor will be tranfpa-'rent, and certain long, and cryftalline fhoots begin to form therein. It 'has no fcent, the tafte is fomewhat bitterifh, and perfectly nitrous. Dilute

(*a*) Philof. Tranfact. *Lowth.* Abridg. vol. III. p. 358.

'the liquor a little more, boil it for a moment, ftrain it hot, evaporate to 'a pellicule, and actual cryftals of nitre will fhoot. Strain the remaining 'liquor, infpiffate, and cryftallize as before; thus more true nitre will be 'obtained.

'2. If any other pure fixed alcali, prepared from tartar or pot-afh, be 'ufed in this experiment, inftead of fixed nitre, the fuccefs will be in every 'refpect the fame; and no difference be found in the nitre produced.'

The ufe.

The illuftrious Mr. *Boyle* conceived fo highly of this experiment, that he thought proper to write a treatife upon it; and truly it is one of the moft capital difcoveries in chemiftry; as fhewing how, from the ftrongeft and moft corrofive acid and alcali, immediately to produce, by a bare proportional mixture, a neutral, mild, cooling falt, in no refpect corrofive. Here a highly odorous and volatile acid is, in an inftant, attracted into a fixed alcali, with the lofs of all its odour and volatility, fo as to bear a fire of fufion, without any remaining volatility: whence we may eafily underftand the great attractive force there is betwixt acid and alcali. At the inftant of this conflict, a quantity of elaftic and highly expanfive air arifes, which is only generated in the action of the attraction, and ceafes when that is over: whence air feems to be ftruck out of the bodies of the acid and alcali in the collifion. Hence this action feems to be an attraction, not a repulfion, and perhaps the violent and fudden motion arifes from the expulfion, and breaking out of the air, whilft the alcali and the acid are clofely uniting. Here we fee, likewife, a fubtile liquid acid again forms a firm, folid, faline body with an alcali; and that the alcali, which would before run fpontaneoufly in the air, and the acid of the nitre, fcarcely by any other means to be rendered folid, afford a falt upon uniting, which, when dry, will remain firm in the air, and even acquires a folid form, or fhoot into cryftals in water. Here again, we fee, that an alcali may be determined by an acid, into that kind of falt which afforded the acid; and, therefore, that alcali is indifferent to every acid, and capable of uniting with them all, tho' always fo as to regenerate the falt which afforded the acid. Hence alcali appears a kind of unimpregnated or female body, to be impregnated by an acid, which acts as the male with refpect thereto, and generates its own kind, or preferves its fpecies: and, therefore, the indifferent nature of alcali is determined by the acid. And hence, again, it appears, that the laft principles of nitre may confift of any fixed alcali, faturated with the acid fpirit of nitre; and, therefore, that the nature thereof, the figure, and other properties, may be owing to a conjunction of them both. But whether all nitre originally proceeded from this acid, before pre-exifting of itfelf, and united with a fixed alcali, in like manner pre-exifting by itfelf, I cannot fay; and very much queftion. But that nitre may be made in this manner, and alfo that it may be procured from earth impregnated with the diffolved parts of animals, and the faline parts of vegetables, as alfo with quick-lime, I certainly know; and this is fufficient for me.

PROCESS

PROCESS CXXXVII.

Nitre regenerated in an unfixed ſtate.

'1. INTO a capacious glaſs, with a narrow neck, put three ounces of
' pure volatile alcaline ſalt, prepared according to the hundred and
' ſixth proceſs; dilute it with ſix times its quantity of fair water, and, when
' diſſolved, drop in a quantity of pure ſpirit of nitre; an effervefcence will
' riſe like that of the preceding proceſs. Continue in the ſame manner as
' there directed, till the point of ſaturation be exactly hit; ſoon after which,
' oblong, ſaline, priſmatic, eight-ſided cryſtals will ſhoot, exactly like nitre.
' 2. Again, dilute this compound liquor with twice its quantity of water,
' filter, exhale to a pellicule, over a gentle fire, and ſet the whole in a cold
' place, and nitrous cryſtals will be formed. Proſecute the operation till
' all the ſalt is ſhot, which will appear in the form of ſcentleſs cryſtals of
' nitre, and of the ſame cold, bitteriſh taſte, which is peculiar to nitre.
' Theſe cryſtals eaſily melt in the fire, but at the ſame time fly off, not
' remaining fixed like nitre: they make a flame with all inflammable mat-
' ters, like true nitre; and with oil of vitriol afford a ſpirit, like true nitre.
' Hence they are true nitre, but ſemi-volatile.

The uſe.

This is an excellent experiment, and teaches the ſeveral particulars explained under the laſt proceſs; to which we may add, that here, from two of the moſt odorous bodies there ariſes a perfectly inodorous ſalt; from two violent cauſtics, an exceeding cool and mild ſalt; from two very volatile bodies, a ſalt that is not volatile, except with a conſiderable heat. Here the volatile alcali, of itſelf indifferent, is, by a ſaturating acid, turned into a particular ſalt of the nature of the acid employed, which thus regenerates the body that produced it. Hence we ſee that the volatility of a ſalt depends upon the alcali contributing to its compoſition; which alcali, if fixed, the ſalt is fixed; if volatile, the ſalt is volatile: and that the nature of the ſalt produced depends upon the acid mixed therein. And hence we have the method of procuring a volatile nitre; the diſcovery whereof has exerciſed the labour and induſtry of the chemiſts in all ages. The virtues of the ſemi-volatile nitre, thus prepared, as far as I could obſerve, are of the ſame kind with thoſe of common nitre, or the fixed regenerated kind, tho' more gentle, and differ only as the virtues of ſea-ſalt differ from thoſe of ſal-ammoniac.

PROCESS CXXXVIII.

Glauber's *alcaheſt.*

' PUT the alcaline ſalt, prepared according to the hundred and thirty-
' firſt proceſs, in a glazed diſh, and expoſe it to the open air, in a

'cold quiet place, free from duſt; it will ſoon begin to run; pour off 'what is diſſolved into a clean glaſs. Again expoſe the remainder to the 'open air, and repeat the operation, till the whole ſalt is run into a liquor. 'Much aſhes will remain behind; but the liquor, when ſtrained, becomes 'clear, alcaline, and thick, like oil of tartar *per deliquium.*'

The uſe.

This is that famous liquor of the chemiſts, boaſted as ſo great a ſecret by its inventor *Glauber*, who put it off for the true alcaheſt: but ſecrets, once revealed, are ſlighted; and this ſeems to be the caſe here. By all the experiments I have made, I could never diſcover any thing particular, and which I did not alſo find in oil of tartar *per deliquium*, in whatever caſe I applied it; but *Glauber*'s alcaheſt is prepared with more difficulty, obtained in leſs quantity, and comes dearer: and hence, perhaps, it pleaſes better.

PROCESS CXXXIX.

Nitrum nitratum.

'TO eight ounces of the lixivium of pure nitre, put thirty drops of 'the ſtrongeſt ſpirit of nitre; evaporate to a pellicule, and cryſtallize 'after the common manner: perfect nitrous cryſtals will be thus obtained, 'but of an acid taſte.

The uſe.

This proceſs ſerves to ſhew how certain ſalts may be united with the acids themſelves afford, into the form of a compound ſalt. And by adding more, or leſs of the ſpirit, the ſalt may be made more or leſs acid; but the more acid it is made, with the more difficulty it afterward dries, and keeps dry; being thus always apt to run in the air. The nitre, thus prepared, is advantageouſly uſed in burning fevers, attended with a dry, foul tongue, and thirſt.

PROCESS CXL.

Vegetating nitre.

'IF in the preparation of *Glauber*'s ſpirit of nitre, according to the hun-'dred and thirty-fourth proceſs, there are taken four parts of nitre, 'and one of oil of vitriol, and after all the ſpirit is entirely driven off, 'the white ſalt, remaining perfectly dry in the retort, be left in the open 'air, its ſurface will ſoon begin to be covered with a thick long down, as if 'it grew; which phænomenon I do not remember to have obſerved in other 'ſalts. But if the ſalt be diſſolved in water, ſtrained, and evaporated to 'dryneſs, in a cylindrical glaſs, then kept expoſed to the open air, its upper 'ſurface will often appear thick-ſet, with a kind of actual little branching

'plants;

'plants; all which diſſolve away upon the application of heat, ſo as to 'leave the ſurface even; but upon expoſing the veſſel to the open air, in 'a quiet place, they have grown up as before: thus ſeveral times exhibiting 'the reſuſcitation of plants, as it were from their own aſhes, of which ſome 'of the chemiſts have formed ſo many fables; and I have ſometimes ſuſ-'pected the thing might, perhaps, be done by this means.

The uſe.

This curious experiment ſhews that the great diſpoſition which nitre has to cryſtallize, affords an opportunity of imagining a kind of artificial vegetation, ſuch as ſome over credulous artiſts have feigned, but never, I conceive, exhibited, under the title of vegetable reſuſcitation.

PROCESS CXLI.

Spirit of nitre with bole.

'1. TAKE a pound and half of purified nitre, reduced to powder, 'and four pounds and an half of common red bole, mix them 'well together, put the mixture into an earthen long-neck, ſo as not to riſe 'into the neck thereof; as the long-neck lies horizontal in the furnace, 'after the manner deſcribed in our chapter of furnaces, let two of theſe 'long-necks be uſed at once, and lute on their receivers (*a*); apply a gen-'tle fire at firſt to warm the matters, and increaſe it a little every quarter 'of an hour, till, by degrees, the furnace and veſſels become thoroughly 'hot. A moiſt vapour will now begin to come into the receiver; increaſe 'the fire ſo far, by degrees, in the ſpace of half an hour, till the vapour 'comes over reddiſh; and gradually raiſe the heat till the vapour comes 'over perfectly red. Continue thus for three hours; at length raiſe the fire 'ſo high, till the long-necks grow red hot, ſo that the ignited matter may, 'in the long-necks, be perceived thro' the glaſs receivers; and keep the 'fire up to this height for two hours; then let all cool, and as ſoon as the 'necks of the long-necks are cooled, take off the receivers, with care to 'avoid the fume; pour the diſtilled liquor, thro' a funnel, into a glaſs-veſſel, 'which, being exactly fitted with a glaſs-ſtopper, is to be ſet in a cold 'place. This will be a very ſtrong, acid, ſharp, and cauſtic ſpirit of nitre, 'exhaling very red fumes, like *Glauber*'s ſpirit of nitre; but is never ſo ſtrong. 'When the diſtillation has been well performed, I have had of this ſpirit 'nine ſixteenths, or one half and a ſixteenth in reſpect of the nitre em-'ployed.

'2. The bole, remaining behind, ſtill retains a taſte of the nitre. I have 'boiled the whole of it in a large proportion of water, ſtrained the hot li-'quor, and repeated the boiling with freſh water, till it would fetch out 'nothing more; then boiling all the ſtrained lixiviums, which were now

(*a*) For fuller inſtructions relating to the furnace and apparatus of the veſſels here required, ſee the chapter of furnaces and proceſs 144.

'clear

' clear, and of a nitrous tafte, I evaporated them to a fmall quantity, of the ' thicknefs of milk: it had a tafte not very fharp, but lixivious, as if fome-' what alcaline: and examining it, by putting acids thereto, I found it in ' fome meafure alcaline, a little changed from the former nature of nitre, ' and yet not true alcali.

' 3. Great care is to be taken in this operation, that the coals thrown into ' the furnace, during the diftillation, are firft thoroughly heated, otherwife ' they would break the long-necks by the coldnefs, fuddenly driven out of ' them by the fire. Hence care alfo fhould be taken upon opening the door ' of the furnace to feed the fire, left the cold air, entring in too fuddenly, ' fhould crack the veffels; and be cautious, likewife, left upon opening the ' door of the furnace, the flame fhould violently burft out into the face of ' the operator; or be received, with the air, into the lungs.

' 4. Pure nitre, by itfelf, in a glafs-retort, and a fand heat, melts long ' before the glafs; and when heated fo as to melt, it receives no more heat ' by increafing the fire; and tho' long kept in this ftate, it affords no acid ' fpirit, but remains fixed without confiderably exhaling. And if long de-' tained thus in a *Heffian* retort, and the fire be violent, the falt, at length, ' paffes thro' the pores of the earthen veffel, without fending any acid fpirit ' into the receiver; but is at length almoft loft, by tranfuding thro' the ' veffel.

' 5. Nitre mixed with thrice its quantity of bole, brick, or tobacco-pipe-' clay, reduced to powder, then put into a crucible, and fet in the fire, does ' not melt, but fume, affords an acid vapour, and thus, in a fhort time, ' evaporate its greateft part into the air.'

The ufe.

1. Hence it is plain, that the fire acting upon nitre, whilft it is prevented from melting, by the interpofition of thrice its quantity of a matter that will not flow in the fire, has a very different effect, and heats much more ftrongly than when the falt flows in the fire, and, therefore, cannot be farther changed thereby. The change is effected by rendring a fixed fubftance volatile, a mild one fharp, changing a folid into a fluid, and a neutral body into a violent acid; all which can only be obtained by preventing the fufion of the falt, as, in the hundred thirty-fourth procefs, we did by means of oil of vitriol in a fand-heat. But whether in the fpirit, thus prepared, there is not alfo fome liquor proceeding from the bole, has been much queftioned; chiefly becaufe the bole, once employed in this operation, is faid to be incapable of ferving again; for that the fpirit of nitre cannot hence be obtained. But certainly, the fpirit of nitre prepared with the oil of vitriol, and that with the calx of vitriol, under the name of *aqua fortis*, and that with calcined alum, are alike to this, almoft without the leaft difference; and yet no bole was employed in their production. Let the experiments, therefore, on each fide of the queftion, be collected: a longer time will fhew what a fhort one cannot.

2. Again, fome difcerning chemifts among the moderns fuppofe nitre to be made up of alcali, and a particular nitrous acid, as we explained under the

the hundred and thirty-fourth, hundred and thirty-fixth, and hundred and thirty-feventh proceffes. The incomparable Mr. *Homberg* has, by a laborious experiment, and a fubtile calculation, here determined the proportion of the alcali to the acid, to be as four hundred and eighty to a hundred and eighty three (*a*). But here, by diftillation, nine fixteenths of acid are obtained, in refpect of the nitre, and yet fcarce any alcali is obtained from the remainder; whence it certainly appears that this acid proceeds from the nitre, as changed by the fire, and not by a feparation of the acid and the alcali, pre-exifting in the compound before the operation: fo that the wonderful action of the fire here performs what is otherwife effected by the oil of vitriol. Since, therefore, true nitre is never found fpontaneous in nature, and its fpirit never without the affiftance of oil of vitriol or fire, whilft the falt is prevented from melting; we conceive that the acid fpirit of nitre no where exifted in nature, before the difcovery of the method of procuring nitre, and drawing a fpirit from it; fo far we mean as can be known from chemical experiments. Thus it was impoffible both for art and nature to make gunpowder before the difcovery of nitre, tho' even all other natural things were known, except nitre alone (*b*).

3. But when the red colcothar of vitriol, or calcined alum, is mixed with nitre in a certain proportion, fo as to hinder it from melting in the fire, and, confequently, fit it to fuftain a greater heat; it thus alfo affords an acid fpirit in red fumes, in every refpect refembling the true fpirit of nitre of the prefent procefs, and in a large quantity. We are here to confider that the colcothar, and burnt alum, conceal a large quantity of a very ftrong acid, called oil of vitriol, or fpirit of alum; and thefe acids, being actuated by the fire, enter the nitre, feparate its fpirit, fubftitute themfelves in its place, and thus leave for a remainder a *caput mortuum*, containing that called the *panacea duplicata*, which is confiderably like the falt produced in the making of *Glauber*'s fpirit of nitre: and this is the origin of all the *aquæ fortes*, whofe production entirely depends upon the reafon above affigned, in the hundred and thirty-fourth procefs. This tranfmigration of faline acid fpirits is a wonderful operation, whilft one of them poffeffing the place of another, drives the former out, and thus appears to produce unexpected tranfmutations. And by what we can hitherto learn, oil of fulphur made by the bell, and oil of alum, are perfectly the fame acid; having all of them this property, that they feparate all the other known acids from the bodies that hold them, render them perfectly volatile, poffefs the places thereof, and driving out the former acid fpirits, form with the remainder a new body, of its own particular nature, according to that of this ftronger acid. *Aqua fortis* is a mere fpirit of nitre; colcothar can, by no violence of fire, tho' ever fo long continued, be deprived of all its acid: hence the *caput mor-*

(*a*) Here feems to be no allowance made for the aqueous part, which holds the acid falt diffolved. This aqueous part is hereafter faid to be as 60 to 19 of the true acid. See procefs 148. *ad fin.*

(*b*) This fubject, as to the generation of nitre, may receive confiderable light from *Stubb*'s anfwer to *Henfhaw*'s *Hiftory of nitre*; and the younger *Lemery*'s two papers upon the origin of nitre, in the *French* Memoirs.

tuum of vitriol and alum abound with a ſtrong acid, which the fire cannot drive over: this acid is attracted by the other part of the nitre, which cannot be converted into acid, and uniting with this part, by the force of the fire, makes a new kind of ſalt, and ſends over all the volatile acid ſpirit in the form of *aqua fortis*. But they who promiſe by the art of chemiſtry to convert the whole body of nitre, by diſtillation, into the ſpirit of nitre, by a true change of the whole, ſo as from a pound of nitre to procure a pound of ſpirit, aſſert a thing which to me ſeems perfectly impoſſible, and contrary to the nature of the art. I have made various experiments to aſſure me of this truth.

4. The ſpirit of nitre of the preſent proceſs, *Glauber*'s ſpirit of nitre, and the common *aqua fortis* well prepared, afford a nitrous acid, diſtinguiſhed by its red fumes from all other acids, and always diſcovers itſelf by means of theſe fumes, and its particular odour. When mixed with fixed alcali, they regenerate a true nitre; they diſſolve ſilver, and have all the other effects mentioned of them in our chapter of menſtruums.

PROCESS CXLII.

The depuration and cryſtallization of ſea-ſalt.

'DISSOLVE common ſea-ſalt in ſix times its quantity of rain-water; 'ſtrain the ſolution hot thro' a cloſe linen bag, ſo often as to render 'it perfectly limpid; then exhale away in a glaſs-veſſel one ſixth part of the 'water; ſet the remainder in a quiet, cold place for three days, in a veſſel 'covered, to keep out the duſt; if it depoſites any fæces, pour off the 'liquor from them by gently inclining the veſſel; if it depoſites none, the 'liquor was perfect, and may now be evaporated to a pellicule: again ſet it 'in a cold quiet place, for twenty-four hours, during which time it will ſhoot 'into cubical cryſtals. Carefully pour off the liquor remaining after cry-'ſtallization, dry the ſalt with a gentle heat, and keep it ſeparate: this is 'the ſalt that I commonly employ for chemical uſes. Let the remaining 'ſolution be again evaporated to a pellicule, and ſet to ſhoot as before. By 'thus continuing to repeat the operation, the liquor will at laſt become thick, 'unctuous, auſtere, and hard to dry, and ſcarce afford any cryſtals. If 'the ſalt, thus purified, be decrepitated in the fire, and afterwards fuſed 'with a ſtrong heat, then poured out upon a dry marble, it reſolves in 'the air, and depoſites earthy fæces; from which the liquor being carefully 'ſeparated, then inſpiſſated, calcined, poured out, and ſuffered to run in the 'air; the operation being thus repeated, the ſalt at length vaniſhes into the 'air, as a very ancient chemical writer has truly obſerved.'

The uſe.

What was ſaid of nitre, in the hundred and twenty-ninth proceſs, is farther confirmed by the preſent experiment. There is only one method of cryſtal-

cryſtallization, for procuring ſalts pure and ſimple, whilſt their innate virtue, when the ſalts are diluted with a certain proportion of water, unites the ſimilar parts together, and ſeparates the diſſimilar; and the water, being attracted more by one ſalt than another, cauſes one to ſeparate from the water, ſooner than another. And unleſs ſalts be thus previouſly depurated, it is in vain to expect they ſhould afford pure ſpirits, which are neceſſary to certain operations. If any ſea-ſalt were in nitre, the nitre, upon diſtillation, would afford not an *aqua fortis*, but an *aqua regia*; and the ſame holds true of ſea-ſalt, if any nitre be mixed among it. The ſalt, thus obtained, is ſuch a diſſolvent of gold, that without its addition, gold can no otherwiſe be diſſolved, except by fuſing with metals. This ſalt is a wonderful preſervative, by means whereof all the parts of animals and vegetables are kept from putrefaction.

PROCESS CXLIII.

Glauber's *ſpirit of ſea-ſalt.*

' 1. TO three parts of ſea-ſalt, prepared as in the preceding proceſs, ' and put into a glaſs-retort, pour one part of the ſtrongeſt oil of ' vitriol; at the inſtant they mix, a volatile white vapour riſes out, which ' is to be carefully avoided, as being ſuffocating, and capable, if but once ' drawn in with the breath, to ſtop the action of the lungs irremediably. ' Directly apply a large and cold glaſs-receiver, lute the juncture, apply a ' very ſmall quantity of fire at firſt, for a wild ſpirit will long continue to ' come over, ſo furiouſly as to blow thro' the luting, or break the veſſel; ' ſo that the fire muſt be kept gentle, for three or four hours; then encreaſe ' it a little, and a leſs volatile liquor will come over. After eight hours ' have been employed upon the operation, urge the fire till the iron pot ' becomes ignited, and no more liquor riſes; then let all cool, and when ' the neck of the retort is no longer hot, take off the receiver; the liquor ' will fume: and beware of receiving it in with the breath. Pour it into a ' glaſs, well-fitted with a glaſs-ſtopper, and ſet it in a cold place, other' wiſe the glaſs often burſts, by means of the motion of the vapour. If thus ' kept for years, a white ſuffocating vapour immediately breaks out upon ' opening of the veſſel; but if the ſpirit thus produced be carefully diſtilled ' in a glaſs-body, under a chimney, into a receiver, the volatile ſpirit will ' come over, whilſt there remains at the bottom a more fixed liquor, of a ' colour betwixt a yellow and a green. This liquor remains quiet without ' exhaling, but that which comes over into the receiver has a violent ſuf' focating volatility, and may be kept apart as a pure volatile ſpirit of ſalt ' in a cloſe veſſel.

' 2. To three parts of purified and dry ſea-ſalt, put into a retort, add ' two parts of clean rain-water, and one part of the ſtrongeſt oil of vitriol. ' Let the oil of vitriol fall in by ſlow drops, to prevent burſting the veſ' ſel, by the ſudden heat that would riſe from mixing in the whole at once. ' The mixture will grow hot; place the retort in a ſand furnace, and apply

'a capacious receiver; diftil gently for the firft four hours, while the water 'comes over flowly; otherwife, if made to rife brifkly, it always cracks 'the receiver. After this, increafe the fire gradually; the fpirit of fea-falt 'will come over, which is then known to rife, when the liquor runs in 'fpiral veins. Now raife the fire, and gradually urge it, till at length the 'iron-pot grows of a red heat, and no more liquor comes over; at which 'time the fpirit will not fume. Then fuffering all to cool, pour out the 'fpirit, which is now neither fuffocating, nor fmoking. If this be diftilled 'again with a gentle fire, in a glafs-body, there will come over a limpid, 'ungratefully acid water, of excellent internal ufe, being mixed with juleps, 'in fuch diftempers as require it; an excellent fat fpirit will remain in the 'bottom, of a colour betwixt green and yellow.

'3. In both cafes there will be left behind a very white and fixed falt, 'that can only be fufed with a violent fire; this falt will come to be more 'particularly confidered, under the hundred and forty-fifth procefs.

The ufe.

It feems furprifing, that oil of vitriol fhould raife fo volatile a fpirit, by being barely poured upon fo fixed a falt as fea-falt; which fpirit is again fixed by adding fair water to it, and is not generated when the oil of vitriol is mixed with a ftrong folution of fea-falt for diftillation; or again, when the oil of vitriol is diluted with water, and added to the fea-falt: in which three ways this furprifing and fuffocating volatility is fixed, and rendered unhurtful: but when the fpirit, thus fixed and rendered wholefom, is urged with the heat of a hundred degrees, it lets go its water, and remains rich, very fat, thick, gratefully acid, fragrant, and of a greenifh colour, and as perfect as can be any way obtained. But here again are certain limits, for only one certain part of the falt is thus converted into acid fpirit; whilft the other remains fixed with the oil of vitriol. I could fcarce gain more than a third part of pure fpirit, feparate from the water, in proportion to the falt. This fpirit has fome properties in common with other acids, and fome particular. It is particularly grateful to the ftomach, excites the appetite, attenuates mucous humours, refifts putrefaction, and corrects the bile, when either too acrimonious, large in quantity, or corrupted. It is of excellent ufe in curing gangrenes of the gums, mouth, or tongue; it prevents the generation of the ftone, and, according to *Helmont*, helps to diffolve it; it is ferviceable in the ftrangury attending old-age. If the ftrongeft fpirit of falt be mixed with thrice its weight of alcohol, and the two be thoroughly united together, by two or three diftillations, they make a volatile, oily, acid, fragrant and balfamic fpirit of great virtue. This acid fpirit diffolves gold, when very ftrong, or rendered more noble by being feveral times drawn over from fea-falt: in fhort, this liquor exceeds all that can be faid of it: and this is another highly ufeful experiment, which we owe to the induftry of *Glauber*.

PROCESS

PROCESS CXLIV.
Spirit of sea-salt with bole.

'1. TAKE six pounds of pure dry sea-salt, put it into two earthen 'long-necks, each of them containing three pounds of salt; put 'the long-necks into the fire, and cover them with tiles to prevent any 'thing falling in. Let the fire be placed around them, at some distance 'first, and afterwards gradually nearer, and at length up to their sides: 'the salt will for a long time continue to crackle strongly; but this decre-'pitation at length ceases, when both the long-necks are thoroughly ignited. 'When the fire is burnt down, the salt is found white, pulverized, and 'will not crackle, when thrown into the fire. It loses always one fourth in 'the decrepitation, but seems otherwise unchanged; tho' it would easily 'grow moist in the air. It is now fit for distillation; wherein had it been 'employed without decrepitation, the action of the fire would have made it 'leap into the receiver, so as to disturb the operation, and sometimes to 'burst the vessels: but its wild crackling spirit being drawn out by calcina-'tion, it will afterwards calmly endure the fire.

'2. Take three pounds of this salt, as soon as it is decrepitated; grind 'it in a large hot mortar, and presently mix therewith ten pounds of com-'mon red bole; divide the mixture into two parts, and charge two long-'necks therewith, so that the matter may not come into the mouths of the 'vessels, as they lye horizontally in the furnace. Then fit them into the 'reverberatory; building up the open side of the furnace with bricks and 'mortar, so as to leave the necks of the vessels to come thro' the wall; 'apply adopters, and large receivers, in the same manner as in the hun-'dred and forty-first process. Apply a gentle fire, increased by degrees for 'twenty-four hours, that all may become thoroughly hot and dry. Then 'light up a strong fire in the morning; a copious white vapour will come 'over, like white clouds, into the receivers; and dewy drops appear in the 'internal surface thereof. Keep the fire thus for two or three hours, then 'increase it, upon which the receivers usually become clearer, and the spirit 'runs in unctuous veins. And now the fire may be increased to the ut-'most degree, and continued thus for six or eight hours, that the vessels 'may be thoroughly ignited. When no more spirit comes over, leave off; 'let all cool; carefully take away the receivers, and empty the pure liquor: 'it will be acid, gratefully fragrant, of a green colour, and in the quantity 'of about six ounces from a pound: the bole remains saline. I have 'boiled it in water, filtered, and inspissated the lixivium, and thereby pro-'cured a large quantity of a yellow, saline, styptic salt, that was not alca-'line, but appeared a new kind of salt. And this has generally been 'my success; whence I wonder *Beguinus*, and others, should write, that 'they could convert the whole quantity of salt into excellent spirit of salt: 'for my own part, I never could, with the utmost care and caution, in the 'most exact manner, and with the strongest fire, long continued, obtain 'above half the quantity; unless there had chanced to be any moisture ad-

'hering to the falt, or the bole. This diftillation of fea-falt requires a 'ftronger fire than that of nitre.

The ufe.

This fpirit fhews, that a certain part, but not the whole of the falt, is here converted into acid, by means of the fire and the bole. In this diftillation, towards the end, a yellowifh matter inclining to white, always fixes to the upper part of the receiver, and has a fweetifh, ftyptic, faline tafte; and I have found this in greater plenty, when the operation was performed with brick-duft, inftead of bole: it feems to proceed from the falt and fat earth mixed together. The falt obtained from the *caput mortuum* is highly commended by *Helmont*, for the preparation of *Butler*'s ftone; and the fpirit is recommended for the fame purpofes, as that of the preceding procefs, where the particulars, relating to this, are already confidered.

PROCESS CXLV.

Glauber's *fal mirabile*.

'TAKE the white, faline, fix'd falt remaining at the bottom of the re-'tort in the preparation of *Glauber*'s fpirit of fea-falt, to be got out by 'breaking the glafs; bruife it, melt it in a crucible at the fire, with care to 'prevent any coals falling in, and afterwards dilute it with common water. 'Or elfe diffolve the falt, as it remains in the retort, by pouring hot water to 'it; ftrain the lixivium hot, evaporate it to a pellicule, and fet it in a quiet 'cold place; it ufually coagulates into a mafs like ice, or if it remains fome-'what fluid, it turns folid upon being poured into another veffel. If the falt 'be diffolved in fix times its quantity of hot water, then thickened again, 'and fet by in a large glafs, it fhoots into beautiful cryftals, of a particular 'figure, confiderably large, that remain folid, and do not run in the air.

The ufe.

The famous inventor of this falt juftly called it by the name of wonderful; not only on account of its being new, but of the furprifing effects it produces. I know fome chemifts, that are fond of fyftems, pretend that no more than a true *tartarum vitriolatum* is here produced, which was long known before the time of *Glauber*. But *tartarum vitriolatum* has not the properties which are found in this falt, either in refpect of figure, tafte, effects, or any thing elfe: for if this falt be properly prepared, reduced to powder, and mixed with thrice its weight of vinegar, beer, wine, or water, and fet apart, it freezes them. When melted in a crucible, if a fourth part of antimony be thrown to it, by a piece at a time, it wonderfully refolves it; and has many other effects, as to which *Glauber*, *Boyle*, *Becher*, and *Stahl* deferve to be confulted: all of them, men of the utmoft penetration, in giving light to the more abftrufe parts of chemiftry; to whom we muft alfo add the great *Homberg*. In furgery, this falt is of excellent ufe againft putrefactions and gangrenes; it is alfo of ufe, when inter-

nally

nally taken; by gently ſtimulating, reſolving, purging, and promoting of urine.

PROCESS CXLVI.

Sea-ſalt regenerated.

'DILUTE four ounces of oil of tartar *per deliquium*, with thrice its ' weight of fair water; put them into a tall and large glaſs-body, ' with a narrow mouth, and heat the liquor ſtrongly. Then, by means of ' a funnel, let fall into it, by a drop at a time, *Glauber*'s ſpirit of ſalt, or that ' prepared with bole; a great effervefcence will riſe. When this is over, ' ſhake the glaſs, and mix all well together; then drop in more ſpirit, and ' mix as before, till the alcali is perfectly ſaturated with the acid. Now let ' the liquor reſt, and gently pour it from its fæces into a filter; evaporate ' to a pellicule, ſet it in a cold quiet place, and perfect cryſtals of ſea-ſalt ' will be obtained. Treat the remaining liquor in the ſame manner, after ' the firſt cryſtallization is over, and this will afford the ſame ſalt, which will ' be fixed in the fire, and have all the other properties of native ſea-ſalt.

The uſe.

The vegetable alcali, which indifferently receives any acid, is here determined by the acid of ſea-ſalt; and being ſaturated therewith, aſſumes the nature of that ſalt: and if this be compared with the hundred and thirty-ſixth proceſs, exhibiting the regeneration of nitre, it ſeems greatly to ſtrengthen the doctrine of acids, alcali, and compound ſalts.

PROCESS CXLVII.

The regeneration of ſal-ammoniac.

'TAKE four ounces of the alcaline ſpirit of ſal-ammoniac; dilute it ' with thrice its weight of pure cold water, in a tall capacious glaſs-' body, with a narrow mouth; let fall into it, by drops, thro' a funnel, to ' direct it into the liquor, the ſtrong ſpirit of ſea-ſalt, prepared in either way ' above-mentioned; there ariſes a great effervefcence: continue to drop ' in the ſpirit, till the point of ſaturation be perfectly hit; but in this re-' ſpect, great caution is required; becauſe, if the acid prevails, more ' than is requiſite to a perfect ſaturation, it remains united to the ſalt: ' whereas, if the acid abounded in the fix'd ſalt of the preceding pro-' ceſs, it may again be driven out by fire; but if this were attempted in the ' preſent caſe, both the acid and the ſalt, as not being here fixed, would ' evaporate together. If therefore the ſaturation be perfect, the liquor will ' be limpid, ſcentleſs, and of the particular taſte of ſal-ammoniac; and tho' ' boiled over the fire, affords no ſaline exhalation. Strain the liquor, eva-' porate to a pellicule, ſet it by, and there will ſhoot a fine woolly ſalt, per-

' fectly

'fectly after the same manner as in the lixivium of sal-ammoniac thus treat'ed. If the liquor were to be inspissated, till a dry mass remained at the 'bottom, it would be a white salt, in every respect ammoniacal; and may, 'by a proper fire, be raised into the true flowers of sal-ammoniac.'

The use.

The volatile alcali of animal and vegetable substances, which, of itself, indifferently receives all acids, is here determined, by the acid of sea-salt, into a semi-volatile sea-salt. Hence the rule appears to receive confirmation, that acids determine alcalies into their own nature; whilst the alcali, either gives fixedness or volatility, according as itself is fixed or volatile. And, therefore, as a large quantity of volatile alcali, is continually generated from putrefied animals and vegetables; if there was in nature a spirit of sea-salt floating about in different places, sal-ammoniac would, in these places, be continually produced: and the same spirit meeting with a fixed alcali, produced from the ashes of vegetables, would immediately afford a true fixed sea-salt. But tho' it is easy to manifest these fixed alcalies by experiments, yet it is very difficult to shew the existence of such acids in nature; unless we had the secret of Mr. *Boyle*, who declares, that by a secret and long continued digestion, sea-salt may be so disposed as to part with its acid spirit by a gentle heat, before its water; and this without any addition (*a*).

PROCESS CXLVIII.

Tartarum vitriolatum.

' 1. TAKE three ounces of pure oil of vitriol, dilute it with thrice the 'quantity of warm water, in a tall capacious glass-body with a nar'row neck; add to it, drop by drop, a quantity of oil of tartar *per deli'quium*, till the point of saturation is perfectly obtained: otherwise a perni'cious acrimony either acid or alcaline remains. In this experiment a vio'lent effervescence will arise; and a white salt begin to appear at the bottom, 'long before the saturation is completed. After this point is found, shake 'the vessel for a considerable time, and taste the liquor; if it tastes neither 'acid nor alcaline, take a little thereof, and heat it, divide it into two parts, 'and to one, add a drop of oil of vitriol, and to the other a drop of oil 'of tartar *per deliquium*, and if no effervescence appears in either, the point 'of saturation, here so requisite for medicinal use, is exactly hit. If any 'effervescence arise upon the addition of the acid, the alcali prevails; and if 'the alcali causes any effervescence, the acid prevails; but when the equi'librium is obtained, let the liquor be entirely dissolved by the addition of 'hot water, so that all the salt may be taken up. Let the liquor be strained 'while it is hot, evaporated to a pellicule, and crystallized. A white salt 'will be obtained, of a neutral taste, that requires a large proportion of

(*a*) In his treatise of *Mechanical Qualities*.

' water to diffolve it: what remains cannot be cryftallized; as happens in ' the cafe of nitre, fea-falt, and almoft every other falt.

' 2. Some eminent chemifts, among whom we reckon *Tachenius*, imagine ' that the oil of vitriol, after having fuffered fo great a fire, carries up ' with it fome volatilized metallic part, that gives a noxious quality to this ' falt, not to be eafily deftroyed; hence they endeavoured to obtain this ' acid native and fimple, without fire, and join it with fixed alcali of tartar. ' They, therefore, diffolved vitriol in water, fo as to make a dilute and pure ' liquor, to which, when filtered, they added oil of tartar *per deliquium*, ' drop by drop; upon which the liquor grows turbid, and the iron, in form ' of yellow oaker, falls to the bottom: they carefully proceed thus, till no ' more precipitate is obtained, upon addition of the alcali. This point they ' carefully obferve, and fet by the mixture, till all the metallic fæces are ' precipitated, then filter the pure liquor, infpiffate, and cryftallize as be- ' fore. Thus a *tartarum vitriolatum* is obtained without fire; and as they ' feem to imagine, without any fufpicion of a fharp corrofive virtue. And ' if there be no blue, or green colour remaining in the liquor, or the falt ' prepared from it, the preparation will be good; but otherwife it will ' retain fomething of copper, and prove malignant.

' 3. When by the like means, a falt is prepared with any pure volatile ' alcali, and oil of vitriol, either alone or diluted with water, a like, but a ' femi-volatile and more penetrating falt is obtained; whereas the former is ' wonderfully fixed. This falt, in whatever manner prepared, appears ' confiderably ponderous and folid; and yet at the fame time is mild and ' opening.'

The ufe.

The virtue of this falt is efteemed highly opening, if taken upon an empty ftomach, diluted with broth or whey, and affifted with the exercife of the body; for thus by attenuating, refifting putrefaction, and ftimulating, it opens the obftructed *vifcera*, fo as to have acquired the name of the univerfal digeftive: but *Tachenius* calls it an unmetallic vitriol. From the hundred and thirty-fixth, hundred and thirty-feventh, and three laft proceffes, it appears, that the moft corrofive alcalies and acids grow perfectly mild upon mixing together. Whence we learn that two poifons, as they would prove, if taken feparate, may be rendered innocent, if drank mixed together; or even that one may be corrected by taking the other foon after. Hence alfo we fee that water may lie wonderfully concealed in falts, and at length be fet free from them; for the acid fpirit of nitre contains fixty parts of water, to nineteen of true acid; fpirit of falt holds fifty-two parts of water, to thirteen of acid; and oil of vitriol fixty of water, to thirty-feven of acid; even fuppofing all thefe liquors highly rectified: fo large a quantity, therefore, lay concealed in decrepitated fea-falt. And hence we learn that there are but very few fimple foffil acids; as the acid of alum, vitriol, and fulphur is the fame; *aqua fortis*, and fpirit of nitre have no difference; and the fpirit of fea-falt, falt-fprings, and fal-gem are all the fame.

II.

PROCESSES *upon* SULPHURS.

PROCESS CXLIX.

The examination of ſulphur.

'PERFECT ſulphur is found in the mines, under very different forms; ' ſometimes ſmooth and yellow, ſometimes yellow and almoſt tran- ' ſparent like amber, ſometimes red and almoſt tranſparent, like ruby, ' but more frequently of an opake grey colour. Any of theſe ſorts being ' put into a crucible, eaſily melt in the fire, and ſo long appear tranſparently ' red; but when cold, they again become opake. Sulphur, as ſoon as melt- ' ed, readily takes flame upon the admiſſion of the external air, and burns ' blue; the vapour whereof, being received with the breath into the lungs, ' proves ſuffocating to all animals. It entirely burns away, or ſcarce leaves ' any fæces behind: if kept melting in the fire without burning, it diſ- ' charges a ſtrong ſmelling, acid, but not ſuffocating vapour; as ſoon as ' melted, ſome part of it goes into the air; and if long kept fuſed, without ' burning, it all of it gradually becomes volatile, and vaniſhes. When cold, ' it is extremely brittle; and when melted by heat, it ſeems viſcous like ' pitch; and in neither form will mix with water. It will never diſſolve in ' alcohol alone; if its powder be mixed with any acids or alcali, it gives not ' the leaſt ſigns of ebullition, or effervefcence; ſo that it has not thus the ' effect of an acid or an alcali. If taken crude into the body, by ſmall doſes ' frequently repeated, it wonderfully cleanſes the firſt paſſages, at length ' purges ſtrongly, and then effectually cures certain cutaneous diſeaſes, and ' ſuch as proceed from worms, or mercurial fumes.'

The uſe.

Hence the nature of ſulphur may be in ſome meaſure underſtood, as found naturally in the earth. And hence it appears why the chemiſts have called it the roſin of the earth: for excepting that it does not diſſolve in ſpirit of wine and alcohol, in other reſpects it approaches to roſin.

PROCESS CL.

The flowers of ſulphur.

' 1. TAKE ſix ounces of common ſulphur, put it into a body of *Haſ-* ' *ſian* earth, apply a capacious glaſs-head, cloſe the junctures with

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'a mixture of equal parts of clay and aſhes, wrought up with water; ſet 'it in a ſand-furnace, ſo that the ſame may almoſt touch the lower rim of 'the glaſs-head. Let the pipe of the head, and likewiſe the body itſelf, 'incline a little downwards, that the moiſture may run into the receiver, 'fixed for the purpoſe. Make a gradual fire, and continue it till the head 'begins to grow dark with the aſcending flowers; a little water will riſe 'and come into the receiver. Cautiouſly keep up the fire, that the heat 'may not melt the flowers in the head, and yet be ſufficient to ſublime 'the ſulphur. Continue thus for eight hours, and at length increaſe the 'fire, till the lower rim of the head grows almoſt ſo hot as to melt the 'ſulphur: the ſulphur will now be ſublimed into a yellow, light, rarified, 'ſoft, powdery ſubſtance, called flowers of ſulphur.

'2. This experiment is ſufficient for our preſent purpoſe: but thoſe who 'make flower of brimſtone for ſale, have entire furnaces built for the pur-'poſe, with two chambers or partitions, one containing the ſulphur to be 'ſublimed, where the fire is placed, and the other adjoining to it, commu-'nicating therewith, and kept cold. Both of them are exactly ſtopped up 'to exclude the air; and thus the ſulphur being urged in one chamber, by 'the heat of the furnace, and rendered volatile, flies into the other which 'is cold, and there collects together. When the operation is ended, and 'all grown cold, the furnaces are opened, and the flowers ſwept out; and 'thus they repeat the operation with freſh ſulphur. And as they thus pre-'pare the flower of ſulphur in large quantities, with little labour and ſmall 'expence, hence it is uſually ſold but little dearer than rough brimſtone.

The uſe.

The ſulphur, by this means, is attenuated and purified; in other reſpects it is not changed; but thus it becomes very fit for internal medicinal uſe. For when thus divided, it exerts its virtues to greater advantage in the body; and thus alſo it proves fitter for external chirurgical uſes, chiefly when it comes to be mixed with balſams, liniments, and unguents. And hence we underſtand its wonderful nature; for tho' ever ſo often ſublimed, it always remains the ſame, without being changed or mixed: it therefore can never become a metal, or enter the compoſition of metals. This, therefore, is not the ſulphur of the philoſophers, nor can ever be made to afford it; as being no more than an oil mixed with an acid. So long as the air is excluded from this ſulphur, heated even to the degree of fuſion, it remains unchanged by the fire; but as ſoon as the free air is admitted, it preſently takes flame, and then ſoon changes, and divides into ſeparate parts. *Paracelſus* directs theſe flowers to be ſublimed from the red calx of vitriol, and recommends them for the cure of exulcerated lungs. I made the experiment, but without finding that theſe flowers, which he ſo much commends, had greater virtues than the common flower of brimſtone.

PROCESS CLI.

The acid ſpirit of ſulphur.

'1. CHUSE a cool, moiſt, ſtill day, and melt pure flower of brimſtone, in an earthen cylindrical pan, three inches deep, and as many over. When the ſulphur is thoroughly melted, but not fired, put the veſſel under a chimney that does not ſmoke, but diſcharges all fumes made upon the hearth. Now light up the melted brimſtone, and immediately cover it with a glaſs-bell, the centre whereof is over the centre of the flame. The bell ſhould firſt be ſuſpended in the vapour of hot water to moiſten its internal ſurface, and let it be ſo ſupported by bricks, ſet triangularly, as not entirely to extinguiſh the flame of the burning brimſtone; otherwiſe the nearer it is to the flame, the better. As ſoon as the flame begins to go out, let there be at hand another ſimilar veſſel full of melted brimſtone, to be fired and applied as the former; and continue thus for a whole day. A ſtrong-ſmelling acid vapour will begin to collect in the bell; eſpecially during the coldneſs of the night; apply a little glaſs-receiver to the bell, which is to be ſet ſo inclining, as that the liquor may gently run out of it into the receiver. Thus by continuing the operation, and increaſing the number of the bells, there will be obtained a gratefully acid, ponderous, yellow, and ſometimes red liquor, that is wonderfully fixed at the fire, ſo as to require almoſt the ſame heat to raiſe it as oil of vitriol. It alſo ſtrongly attracts water; and therefore gradually increaſes its weight in an open glaſs. If all theſe directions be well obſerved, the operation will always ſucceed. The vapour here muſt be carefully avoided.

'2. Mr. *Homberg* finding this method too tedious, has invented a much eaſier and better, whereby five ounces may be obtained in twenty-four hours (*a*). He took the moſt capacious glaſs-receiver he could get, and cut a round hole in the bottom thereof, eight or ten inches wide. This is done by firſt finding the centre of the baſis, by letting a plumb-line fall down thro' the mouth of the glaſs till it touch the bottom, and remain every way equidiſtant from the ſides; the point of contact is marked with a diamond; then ſetting the foot of a pair of compaſſes on that point, and opening them to the diſtance of five inches, the periphery of a circle is ſtruck with ink. When the line is dry, it is to be cut with a diamond, the deeper the better. Then have at hand an iron ring, of the exact ſize with the circle drawn. When the iron is heated, apply it to the round line, and the piece will fly off, and leave the baſis open. When the bell is thus procured, paſte a ſlip of ſtrong linen about the neck, with a loop-hole for a ſtring to run thro', in order to ſuſpend the bell: then have ready a cylindrical earthen pan, ſix inches wide, full of pure melted ſulphur; light it, and ſet this veſſel upon a glazed earthen foot, placed upon

(*a*) See *Memoir. de l'Acad.* An. 1703. pag. 31, &c.

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'the rising part in the middle of a large glazed dish; suspend the bell 'exactly over the middle of the flame, at such a distance as not to extin- 'guish it. Make the sulphur always burn equably, by supplying it with 'new, and taking off the crust with an iron rod, when it grows hard; so 'that the distillation may thus proceed uninterrupted. The other particu- 'lars above-mentioned, of moistening the inside of the bell with a warm 'aqueous vapour, of taking the opportunity of a cold, moist, still air, and of 'a chimney that does not smoke, are here also to be regarded.

The use.

The sulphur sublimed into flowers, is freed from its earth and metallic part. When lighted, after being melted, it burns only on its surface contiguous to the air; its blue flame consists of fire, or the inflammable oily part of the sulphur, agitated by the fire, and a mineral acid, which is the other constituent part of the sulphur, now agitated, attenuated, made caustic and volatile, by the flame. Thus the unctuous combustible matter is consumed by the fire, and the ponderous acid dissipated, which soon after condenses by its own weight, when it gets clear of the flame that throws it off. And hence this vapour becomes so mortal, because the violently caustic acid, thus strongly agitated, comes in contact with the nerves, which move the muscles, that join the interstices of the cartilaginous rings of the *larynx*, *bronchia*, and *vesiculæ* of the lungs; whence it contracts them spasmodically, so as to stimulate the lungs into a panting endeavour to cough, whilst they are entirely contracted, and not suffered to expand by the weight of the air; altho' the breast be dilated with a laborious but fruitless endeavour. The same vapour, shut up with fermentable liquors, stops fermentation; and if strongly repeated, prevents putrefaction in all bodies that otherwise easily putrefy. Hence this fume is a proper preservative against pestilential poison, and the contagion that flies abroad, or remains fixed in goods, so as to infect them. And hence we understand why the flame of nitre and sulphur together, but chiefly of gunpowder, afford a very healthy fume in the height of the plague; for the explosive acid vapour of nitre and sulphur corrects the air; and the same vapour, if received in a small close pent up place, kills insects. This spirit of sulphur, called by the name of *oleum sulphuris per campanum*, is no other than the oil of vitriol, which was lodged in the vitriolic pyrites: and afterwards, joining with the oil of coals, constitutes sulphur. This appears from all kinds of trials; only oil of vitriol is suspected to contain some metallic impression, which is wanting in the spirit of sulphur, prepared from the flower of sulphur. The great *Homberg* has, with much labour and subtlety, computed the quantity of this acid contained in sulphur, and found it to be nearly a tenth part. And thence, perhaps, we have the reason why alcohol will not touch sulphur, *viz.* because its oil is saturated with acid: and again, why a tenth part of alcali, mixed with it by the fire, occasions alcohol to dissolve it, *viz.* because thus having alcali to absorb the fixed acid, it leaves the oil free to dissolve in the alcohol: and again, why sulphur resists acids, and is not resolved thereby: why when once dissolved with its own acid, it admits no more: why metals melted, or calcined with

 sulphur,

ſulphur, are corroded thereby, *viz.* becauſe the acid of the ſulphur, forſaking its own oil, is ſtrongly attracted into the metals, and thus corrodes them into a kind of vitriol. And hence let thoſe leſs ſkilful chemiſts grow more prudent, who endeavour to fix ſulphur; which is only a foſſil acid united with an inflammable oil; and no longer attempt to fix metallic mercury therewith; for ſuch heterogeneous things cannot enter each other: nor can they give the gravity and ſolidity here ſo requiſite, nor indeed the ſimplicity or malleability. This ſpirit of ſulphur, being purified, barely by ſtanding, then mixed with juleps, gives them an agreeable acidity, and renders them a wholeſom drink in all inflammations, and hot diſeaſes, attended with thirſt and corruption. *Helmont* ſays, it is conducive to the prolongation of life.

PROCESS CLII.

Sulphur diſſolved in fixed alcali.

'TAKE nine drachms of pure flower of ſulphur, melt it in a crucible, 'and add two drachms of dry fixed alcali in powder; the ſulphur 'will preſently begin to change of a new and particular odour, and of a high 'red colour; ſtir the mixture over the fire with a tobacco-pipe, then, when 'thoroughly melted and united, pour it out upon a cold marble. It will be 'a red, brittle maſs, ſoluble in water, and ſoon relenting in the air; whereas 'the ſulphur before would neither reſolve by the action of the air, or water.'

The uſe.

The fixed alcali, being here actuated by the fire, intimately unites with the melted ſulphur, attracts its acid, and joins therewith, ſo that the ſulphur reſolves into its two ſeparate principles; yet the oil does not here remain ſeparate, but is intimately united with the alcali, and acid ſalt, ſo as immediately to produce a wonderful ſoap, conſiſting of acid, alcali, and oil; and therefore the combination of the foſſil acid, alcali, and oil, in the compoſition of ſulphur, changes the oil to another nature; but the acid remaining almoſt unchanged, comes out the ſame upon the reſolution: and hence we may underſtand the power of fixed alcali in metallurgy. Sulphur is often mixed with metals, and makes them brittle; but, if fixed alcali be added to them in fuſion, it takes the ſulphur into itſelf, from the metal, and floating upon the ſurface, as a lighter ſoap, leaves the heavier metal, now freed from its ſulphur, to fall to the bottom, in the form of a regulus, whilſt the alcali has no entrance into, or power upon the metal. Hence, therefore, if there be any doubt, whether any foſſil glebe or ore contains ſulphur, the way is to grind and melt it with fixed alcali; for thus the alcali will manifeſt the ſulphur by the colour and ſmell produced.

PROCESS

PROCESS CLIII.

Sulpher diſſolved in volatile alcali.

'MIX any ſtrong alcaline ſpirit, whether prepared from ſal-ammoniac, 'hartſhorn, blood, or the like, with pure flowers of ſulphur; diſtil, 'and cohobate, by which means the ſulphur will be diſſolved: or if the 'mixture be long kept in a cloſe veſſel, and frequently ſhook, by this means, 'alſo, a golden tincture may be obtained.

The uſe.

This proceſs ſerves to ſhew the power which volatile alcali has upon the acid of ſulphur, and the conſequent change thereof. But whether the tincture poſſeſſes ſuch great medicinal virtues, eſpecially in diſeaſes of the breaſt, as an eminent chemiſt imagined, may be juſtly queſtioned.

PROCESS CLIV.

The ſolution of ſulphur in alcohol.

'TAKE ſulphur, firſt opened by fixed alcali, as in the hundred fifty-'ſecond proceſs, and whilſt it remains ſtill hot from the fire, and 'conſequently dry, grind it fine in a hot and dry mortar; put it into a dry 'glaſs, and pour pure alcohol thereon, ſo as to float five inches above it. 'The alcohol thus perfectly diſſolves the ſulphur, as ſoon as it comes in 'contact therewith, into a rich, gold-coloured, unctuous liquor, which, by 'ſhaking, becomes ſtill richer. Let the tincture be decanted clear from its 'fæces, pour freſh alcohol upon the remainder, and this being again 'tinged, ſeparate it, and repeat the operation, till the alcohol becomes 'tinged no longer. Keep all the tinctures mixed together: they make a 'liquor that has a very particular ſmell, tho' not ungrateful, but with ſome 'fragrance. It is of an exceeding aromatick heating taſte, and of a corre-'ſponding medicinal virtue: the fæces left behind are grey-coloured, ſa-'line, and earthy.

The uſe.

Alcohol will not touch native ſulphur, tho' ever ſo long digeſted therewith, but as ſoon as the ſulphur is opened by alcali, it is then eagerly taken up by alcohol; ſo that I ſcarce know any quicker ſolution. Hence we learn the power that alcalies have upon ſulphur, for procuring entrance to alcohol. Sure, therefore, ſulphur frequently lyes concealed in many foſſil glebes, but eſpecially in ores; whence it happens, that a ſimple tincture of ſulphur has often been ſold for the moſt ſecret and valuable metallic tinctures, even to princes: and I remember a boaſted tincture of gold thus put off for *aurum potabile* at a high price. This tincture was made by mixing gold with crude antimony, and the alcali of tartar, or *Glauber*'s alcaheſt, melted

melted and ſtirred together; then the whole being afterwards bruiſed, and brought to powder, it afforded a golden tincture with alcohol: but this, I ſay, was a mere tincture of ſulphur; for the gold here remains unchanged: but antimony abounds with ſulphur, and in melting, the alcali attracts this ſulphur, ſeparates it from the metalline maſs, and opens it; then the alcohol, being added to the whole ground maſs, extracts only the ſulphureous part opened by the alcali, and leaves the gold, or metallic part of the antimony, perfectly untouched. And this obſervation is of infinite uſe in examining numerous other ſham-tinctures; for as ſoon as a ſkilful artiſt knows that fixed alcali is employed in making them, he knows they muſt proceed from ſulphur; becauſe the metallic, or as chemiſts call it, the mercurial part, is never touched by vegetable alcali. In the mean time our tincture of ſulphur affords a wonderful warming medicine, that cauſes eructation, reſiſts acids, and cuts phlegm; a few drops of it being taken upon an empty ſtomach, in mead, *Spaniſh* wine, or any proper ſyrup, which it thus turns white, ſo as to be called the milk of ſulphur. But I could never diſcover its antiphthiſical virtue, as a laſt refuge in ulcerated lungs, tho' I have diligently ſought for it; notwithſtanding the great Dr. *Willis* has wonderfully recommended it in this diſtemper; but I judge ſuch preparations ſhould be more ſparingly praiſed by phyſicians.

PROCESS CLV.

The ſyrup of ſulphur.

'TAKE a drachm of ſulphur, opened with alcali; dilute it with thrice 'its weight of water, wherein it almoſt wholly diſſolves; add to the 'ſolution twice or thrice its weight of ſugar, a little boiled; mix them together, and thus a kind of ſyrup of ſulphur is prepared, containing the virtue of the open'd ſulphur, and may thus be conveniently employed for medicinal uſes. It is made more expeditiouſly by mixing the tincture with 'ſix times its weight of the ſyrup of liquoriſh, or other the like ſyrup.'

The uſe.

What opinion phyſicians ſhould have of this compoſition we hinted above, in conſidering the tincture of ſulphur. The ſyrup is heating, drying, and ſtimulating, which are properties that do not ſuit coughs and conſumptions; eſpecially where the body is wore down, and attended with conſtant ſweats. But hence we advantageouſly learn, how wonderfully the powers of foſſils may be concealed in almoſt every thing; for if any foſſil glebe, rich in metals and ſulphur, be firſt gently waſhed, ground to powder, calcined with fixed alcali, and afterwards diſſolved in water, ſyrup, wine, alcohol, or other liquors, the alcaline ſulphureous part eaſily diſſolves, and lyes concealed. Whence the liquor receives ſome particular virtue which ſhould be carefully examined, before the liquor is uſed internally.

PROCESS

PROCESS CLVI.

Sulphur diſſolved in vegetable expreſſed oil.

'TO a quantity of any expreſs'd vegetable oil, contained in a glazed ' veſſel, ſet over the fire, add a fourth part of the flowers of ſulphur ' as ſoon as the oil is ſufficiently hot as to diſſolve the ſulphur, which will ' now fall to the bottom of the oil, like a highly red ſhining liquor, and ' they will remain with this degree of heat, for a long time, unmixed; but ' the fire being gradually increaſed, tho' with care to prevent the matter ' from taking flame, at length, when the oil begins to fume, it will inti- ' mately mix with the ſulphur, and the whole become opake, and form a ' new and entire body of the two. If more ſulphur be added, this alſo may ' be eaſily diſſolved by bringing the oil to fume, and almoſt to boil; and ' thus at length a conſiderable quantity of ſulphur may be diſſolved in a ' ſmall proportion of oil, ſo as perfectly to loſe its former nature of ſulphur.'

The uſe.

This is the famous balſam of ſulphur of *Helmont*, *Rulandus*, and *Boyle*, concerning which let the noble authors themſelves be conſulted, who very highly commend it for heating, mollifying, and reſolving, when uſed externally; and internally againſt putrefactions, and ſuppurations of the kidneys and lungs eſpecially, declaring they have thus found a ſecret but ſufficient remedy for conſumptions of the lungs: but, I judge, that by its acrimonious, indigeſtible, and hot unctuous part, it offends the weak lungs, the ſtomach and viſcera of languid perſons, ſpoils the appetite, increaſes thirſt, and parches the body, already too much dried by the diſtemper. And this I ſpeak not raſhly, but upon experience and conſideration; and therefore adviſe it to be ſparingly and cautiouſly uſed, with a careful obſervance of the effect: certainly, it is not without a burning rancidneſs, as being found, when externally uſed, ſucceſsfully to cure pale, cold, watery, mucous, ſanious running ulcers: perhaps, it was hence ſomewhat too haſtily concluded to have the ſame effects when uſed internally; for thus it raiſes and continues a fever. The chemical uſe of the experiment ſhews, that ſulphur, which remained untouched in alcohol, the moſt ſubtile of oils, does expeditiouſly, and almoſt totally diſſolve in a very thick and ſluggiſh oil, ſtrongly heated by the fire; which evidently ſhews, with regard to the hiſtory of menſtruums, that an extreme degree of ſubtilty and penetrability does not here perform what may ſpeedily be effected by a ſluggiſh and viſcous matter. But this is not all; chemiſts often wonder that many foſſils, which remain untouched by the ſharpeſt acid liquors, ſhould yet be ſucceſsfully reſolved by a mild and indolent oil. Sulphur does not yield to any acid menſtruum; for there is no known acid ſtronger than that already contained in the ſulphur, whence others cannot act upon it; but ſulphur is diſſolved by oil: as often, therefore, as a foſſil glebe, when boiled in oil, affords ſuch a ſulphureous balſam, the oil muſt act upon the ſulphureous part of the matter,

unleſs

unlefs we except lead; which is a metal that diffolves into a balfam with oil, as we fhall fee in the hundred feventy-feventh procefs.

PROCESS CLVII.

Sulphur diffolved in a diftilled vegetable oil.

'PUT an ounce of the flowers of fulphur into a tall bolt-head, pour ' thereon fix times the weight of the ætherial oil of turpentine; let ' them boil in our little wooden furnace, for an hour; the fulphur will firft ' melt at the bottom, and part of it be diffolved in the oil that floats above ' it, with a crackling noife, till at length the whole fulphur will appear dif- ' folved in the oil. Let all cool, and a large proportion of the fulphur will ' appear concreted into yellow fpiculæ at the bottom; the balfam remain- ' ing at the top; fo that the fulphur feems precipitated by a true cryftalli- ' zation in this balfam. Pour off the clear liquor entirely from the golden ' fulphureous cryftals, into a clean veffel apart; add frefh oil of turpentine ' to the remainder, boil as before, and all the fulphur will be diffolved ' into a balfam; but when fuffered to cool, it again fhoots into fulphure- ' ous cryftals. Again, pour on more oil, and continue thus, till all the ' fulphur is perfectly diffolved; whereby it will appear, that one part of ' fulphur requires about fixteen of this oil to diffolve it entirely. Keep all ' the balfams, thus prepared, under the title of balfam of fulphur from ' turpentine. This operation requires the utmoft care, as being attended ' with danger; for if the mouth of the veffel was ftopped, the boiling mat- ' ter would burft the glafs with greater violence than has been hitherto ob- ' ferved in any other experiment; of which terrible accident Doctor *Hoffman* ' gives an inftance (*a*).

The ufe.

Hence we fee, that a thin, penetrating, fharp diftilled oil cannot well dif-folve fulphur, tho' a mild, grofs, and indolent oil fo eafily does it, as we faw in the preceding procefs; whence it fhould feem that the more fubtile the oils are, the more unfit to diffolve fulphur, as appears remarkably in alcohol. It appears alfo that fulphur diffolves in diftilled oils, as falt dif-folves in water, till the water is faturated; but afterwards is thrown off into cryftals. The explofive force of this balfam of fulphur is the moft violent of any that is known. This balfam confifts of the oil of fulphur, the oil of turpentine, the perfect acid of fulphur, made by the bell, and a fixed earth (*b*). This balfam is an extemporaneous anodyne remedy in pains of the nerves, and an excellent medicine in fanious, finuous, weeping, watery, and fiftulous ulcers. Internally taken, it is heating, diuretic, and fudorific. It is recommended for cleanfing and healing internal ulcers; it is hence too highly commended for the phthific, ulcers of the kidneys, and for expelling and diffolving the ftone: but the cautious phyfician will recommend only the

(*a*) See *Obferv. Phyf. Chem.*
(*b*) See *Memoir. de l'Acad. Roy.* An. 1709. pag. 46.

gentle

gentle medicines, and be afraid of thofe that operate violently. It is certain that the urine is foon impregnated with a violet fmell, upon taking a little of this balfam; and hence alfo the tinctures of foffils, extracted by art, with diftilled oils, are falfely received for the tinctures of metals. This is called the terebinthinated balfam of fulphur; and as other diftilled oils may be thus mixed with fulphur, the balfams, fo prepared, receives their names from the diftilled oil employed, that gives them their prevailing odour. Hence the *balfamum fulphuris anifatum*, *fuccinatum*, *juniperinum*, &c.

PROCESS CLVIII.

The foap of balfam of fulphur.

'1. TAKE the balfam of fulphur, as prepared in the hundred fifty-fixth ' procefs; dilute it with twice or thrice its weight of the fame oil as ' was ufed in its preparation, and herewith make a foap, in the manner ex- ' plained under the feventy-third procefs. This will be the foap required, ' which *Starkey* in his Pyrotechny fo highly commends from *Helmont*.

'2. Or take the balfam of fulphur, of the hundred feventy-feventh ' procefs, and therewith, inftead of fimple oil of turpentine, make a foap ' in the fame manner as under the feventy-fifth procefs: this foap will ' be the fulphureous foap of the philofophers.'

The ufe.

Thefe proceffes fhew the ways whereby natural fimple fulphurs, as alfo fuch as clofely adhere to femi-metals, as the fulphur of antimony, *&c.* may be joined to fixed alcaline falts, and thus become mifcible with nearly all the animal juices, and exert their virtue in all the veffels of the body. The followers of *Helmont* hence promifed themfelves wonderful medicinal effects, not eafily to be obtained by other means; becaufe in thefe fulphurs, fo opened, they find a great folutive power, which is manifeft by their dif- agreeable odour, their ungrateful, and highly penetrating and heating tafte; but the fame effects may be had in the foap defcribed in the feventy-third and feventy-fourth proceffes, without the difagreeable odour, and rancid- nefs. Thefe proceffes however have their chemical ufe.

PROCESS CLIX.

The balfam, or foap of fulphur, united with alcohol.

'1. TO the terebinthinated balfam of the hundred fifty-feventh procefs, ' contained in a tall bolt-head, add fix times its weight of pure ' alcohol, and make a folution; which having ftood for fome time, the ful- ' phur in part precipitates out of the balfam, into fulphureous cryftals, and ' in part remains diffolved, fo as to afford an alcoholized balfam of ful- ' phur.

'2. Or take the terebinthinated ſoap of ſulphur, as deſcribed §. 2. in the 'preceding proceſs; digeſt it with alcali; and this makes perfectly the ſame 'ſolution, of a very penetrating taſte and odour.

The uſe.

And here is the limit of the proceſſes upon ſulphur; but we muſt obſerve, that when ſulphur is diſſolved with alcalies, and precipitated with acids, the mixture grows white, and affords the ungrateful odour of putrefied excrements, when ſurpriſing phænomena enſue; which alſo hold in other foſſils ſo treated: whence the cauſe may be underſtood. For example, if vinegar be added to the golden tincture of ſulphur, made according to the hundred fifty-fourth proceſs, there ſoon riſes a ſtercoraceous odour from the precipitated ſulphur; and if the tincture of antimony, prepared by melting the antimony with alcali, and then extracting it with alcohol, be mixed with vinegar, the ſame thing happens: and this may help us to underſtand what is obſerved in the proceſſes upon the ſemi-metallic ſulphureous foſſils.

PROCESS CLX.

Sulphur produced from oil and acid.

'TAKE four ounces of pure rectified oil of turpentine, put it into 'a retort, and let fall thereon, by a drop at a time, an ounce of 'highly rectified oil of vitriol; ſhake the retort, after the addition of each 'drop, that it may be thoroughly mixed. The liquor will now heat, ſmoke, 'grow red, and exhale a variable odour. After the whole is thorougly 'mixed, digeſt it for eight days; then apply a capacious receiver, and di'ſtil in a ſand-furnace, the juncture being well luted; a new and particular 'oily liquor will come over. The matter at the bottom appears firſt like a 'fluid *bitumen*, but gradually thickens, and at length becomes pitchy, and 'betuminous; the liquor that comes over is fetid, ſulphureous, and ſuffo'cating, if received into the lungs. If the diſtillation be carefully carried 'thro' with ſucceſſive degrees of fire, there will at length ariſe a true ſul'phur into the neck of the retort, as may appear from its form and manner 'of burning.

The uſe.

Hence we learn the artificial method of preparing bitumen and ſulphur; and that the fixed acid of vitriol, alum, and burnt ſulphur, is the incombuſtible baſis of ſulphur, whilſt the other part is the combuſtible pure oil; which two, by their intimate union, compoſe ſulphur. If this factitious ſulphur be burnt, its oily part affords a flame without ſmoke; and the other part, in the burning, affords an acid, cauſtic, ſuffocating vapour, which is preſervative and ponderous, ſo as not to riſe high, and if condenſed by a glaſs-bell, it drops down into oil of vitriol, exactly like that of the natural ſulphur. A pure inflammable oil ſeems to be collected in ſulphur, ſuch as can ſcarce

be

be otherwife obtained; whilft the grofs, uninflammable, terreftrious, or other faline matter is excluded in this combination: no other acid, produced by nature or art, will make fulphur by mixing with oil. The acid of vitriol, wherever it be, or wherever fubtilely concealed, joins with any inflammable oil, fo as to make fulphur. Tartar of vitriol, *Glauber*'s *fal mirabile* of fea-falt, and of nitre, the falt of vitriol, burnt alum, and other bodies, containing this acid, as often as they are, by means thereof, joined with an inflammable oil, always afford true fulphur. Hence, this acid alone has the property of producing fulphur, whilft all inflammable oils ferve therewith for the fame purpofe; and hence fulphur can never be produced where this acid did not pre-exift: whence numerous obfcure particulars may be underftood in the chemical hiftory of foffils and metals; and therefore, whoever would explain them, fhould remember what is here delivered. To give an example from *Becher:* melt *Glauber*'s *fal mirabile* in the fire, throw powdered wood-coals thereon, a fulphureous flame arifes, and a brown mafs is left at the bottom, which being diffolved in water, and precipitated, a true fulphureous matter is obtained. Here it is plain, that the oil of vitriol in the *fal mirabile* lays hold of the inflammable matter in the coal, and becomes fulphur: therefore, in determining the effect of any chemical operation beforehand, we muft cautioufly examine whether any of the matters employed, either manifeftly, or fecretly contain the oil of vitriol, alum, or fulphur, and whether any inflammable matter is alfo applied; for in this cafe the action of fulphur is immediately produced.

PROCESS CLXI.

Sulphur obtained from alcohol and acid.

'INTO a tall glafs-body put eight ounces of alcohol, prepared without 'alcali; let fall to it, by a drop at a time, highly rectified oil of 'vitriol; fhake the glafs well after each drop, and reft a little, otherwife 'a great heat, and fuffocating vapour would arife; continue thus, by de-'grees, till an ounce of the oil of vitriol is added. The mixture will 'have the fweet fragrance of fouthern-wood, which will fpread over the 'whole place; but it ought to be avoided, as being fuffocating; if receiv-'ed in a fmall quantity into the lungs, it caufes a violent cough; and if 'received in a large quantity, at once, I judge, it might prove mortal: 'the liquor will become reddifh. Let it now be gently digefted, in a clofe 'veffel for five days, then diftil it gently in glaffes clofe luted; a wonder-'ful fubtile fpirit will come over, which proves incredibly fuffocating, and 'is fo much the more dangerous as, by its grateful fmell, it treacheroufly 'leads one to take it in freely. Continue this gentle diftillation for fome 'time, till the mixed matter grows black; then the fpirit, which laft came 'over, will be exceeding fweet and fragrant. And now there will begin 'fomething acid to rife, which was not in the former liquor; then change 'the receiver, ftill keeping a gentle but conftant fire, that the liquor may 'rife flowly; for if the fire was to be urged too ftrongly, but for a moment,

'the matter would immediately ſwell and rarify, ſo as to come over at 'once into the veſſels, and diſturb the operation. If the diſtillation be thus 'gently continued, there ariſes an aqueous, fetid liquor, and along with it 'another that is ponderous, pure, limpid, and keeping ſeparate and un-'mixed with the phlegm. After all this is come over, and about one half 'of the whole, again change the receiver, and diſtil by degrees of fire up 'to the higheſt; a fetid liquor will ariſe that does not mix with the former 'ponderous kind: at the bottom of the veſſel remains a black, brittle, and 'uninflammable matter, tho' otherwiſe, in ſome degree, approaching to ſul-'phur; ſo that by this means we have three diſtinct liquors ariſing from 'this mixture, as alſo a ſuffocating vapour, and a fixed *caput mortuum*, of a 'very particular nature, remaining behind.'

The uſe.

The ſtrongeſt foſſil acid, by thus barely mixing with the moſt ſubtile vegetable oil, or alcohol, cauſes ſuch a violent heat, as, if imprudently mixed, almoſt to take flame, and produce a conſiderable efferveſcence. At the inſtant of mixing there ariſes a ſweet odour, which diffuſes itſelf widely; but by a long digeſtion, the diſagreeable odour of garlick is produced. The ſweet ſuffocating odour is attended with an acid. Here, (1.) a ſpirituous, fragrant, ſuffocating, inflammable, and tartiſh liquor is ſeparated; whereas the oil of vitriol was a little before ſo fixed, and no way fragrant. (2.) There comes over a fetid, ſulphureous, aqueous, uninflammable acid liquor, tho' neither the alcohol, nor oil of vitriol contain much water. (3.) There comes over a limpid ponderous liquor, that ſmells and taſtes gratefully aromatic, but will not mix with the two former, yet diſſolves in alcohol, and then extracts ſomewhat of a tincture from calcined gold, and hence is eſteemed the philoſophical oil of vitriol. It is certainly a dulcified oil of vitriol, concerning which *Iſaac Hollandus*, *Geſner* (*a*), Mr. *Boyle* (*b*), but particularly Doctor *Hoffman* (*c*) may be conſulted. The black fæces being diluted with water, return almoſt into acid oil of vitriol. We have here a great many unexpected phænomena from a ſimple combination; perhaps this may be the philoſophical ſpirit of wine, which, by its fragrance, calls in the neighbours while it is made, according to *Lilly*'s account of it. Perhaps it is the dulcified fragrant ſpirit of vitriol of *Paracelſus*, which he eſteemed powerful in the falling ſickneſs; and poſſibly the tincture prepared with it from gold is a ſpecies of *Paracelſus*'s *aurum potabile*, digeſted in the ſtomach of the oſtrich. Certainly, this operation may excite the truly curious to examine with care, whether there be any thing of theſe great ſecrets concealed therein. We find it does not produce true ſulphur, but only certain properties thereof.

(*a*) *Conrad. Geſner. Euonym.*
(*b*) Abridg. *Boyle*, Vol. III. p. 391.
(*c*) Diſſert. Phyſ. Chym. p. 173——180.

III.

III.

PROCESSES *upon* METALS.

PROCESS CLXII.

The vitriol of iron.

' 1. DROP pure oil of vitriol into eight times its quantity of fair ' water, contained in an urinal glaſs, and ſhake them well toge- ' ther, ſo as to make one pure liquor; throw in a ſmall proportion of clean ' and bright filings of iron; a great ebullition will ariſe, and the liquor ' become opake, hot, and of a duſky colour; and a perfectly foſſil vapour, ' of a particular odour, will ariſe, ſomewhat reſembling that of garlick. ' When the efferveſcence is over, and the former iron diſſolved, throw in ' more, and continue thus till a part of the filings remain undiſſolved at ' the bottom; then let the liquor reſt to purify, and depoſite its fæces: ' what floats above then will be green, and of a ſweetiſh ſtyptic taſte.

' 2. Let this liquor be filtered, and in a clean glaſs evaporated to a pelli- ' cule; ſet the veſſel in a cold, low, ſtill place, and there will ſoon ſhoot to ' the bottom bright tranſparent green cryſtals like emeralds. Let the liquor ' be poured off from them, dry them gently in a warm air, upon paper, ' and keep them in a glaſs, where they will long preſerve their form. The ' remaining liquor, being inſpiſſated as before, produces new cryſtals; and ' thus at length almoſt the whole liquor is converted into vitriol; tho' the ' firſt cryſtals are always the beſt.'

The uſe.

Iron attracts to itſelf the foſſil acid of oil of vitriol diluted in water, exactly as alcali did in the preparation of *tartarum vitriolatum*, according to the hundred forty-eighth proceſs; in which reſpect, therefore, iron and alcali agree. The iron, thus united with the acid, alſo becomes ſoluble in water; and hence the compound acquires the nature of a metallic ſalt. It conſiſts of water, metal, and acid, united together in a certain proportion: and ſo long as this proportion remains, ſo long the maſs continues ſhining and tranſparent; but as ſoon as only the water is ſeparated from it by any conſiderable heat, the whole maſs preſently becomes opake, loſes its pleaſant greenneſs, and acquires a grey colour; in this reſpect alſo reſembling the cryſtals of ſalts; whence the chemiſts have called it the ſalt of iron, as alſo becauſe it flows in the fire: others rather call it the magiſtery of iron, becauſe the whole body of the iron is concreted with its ſolvent into an uniform ſolid maſs. It is alſo called vitriol of iron, becauſe it perfectly, in every reſpect, reſembles native foſſil vitriol. And hence we underſtand the method,

method, whereby the ſolid bodies of metals, upon uniting with acids, may become, like ſalts, diſſolvable in water, and potable, and thus acquire a new metallic ſaline taſte, and alſo particular medicinal virtues. If the ſalt of iron be diluted with a hundred times its quantity of water, and drank in the doſe of twelve ounces, upon an empty ſtomach, walking gently after it, it opens and relaxes the body, purges, proves diuretic, kills and expels worms, tinges the excrements black, or forms them to a matter like clay, ſtrengthens the fibres, and thus cures many different diſtempers. The like taſte, odour, and colour, and the like blackneſs of the excrements, have occaſioned many to imagine that the chalybeate waters were thus produced by nature; eſpecially, becauſe thoſe liquors, when expoſed to the air, depoſite a copious yellow ſediment or oaker: but Dr. *Hoffman* has prudently corrected this error, by means of experiments, in his noble work of mineral waters. However, we muſt obſerve that this ſalt of iron, meeting with alcaleſcent and putrid matters; and thus having its acid ſolvent drank up thereby, is turned into an aſtringent, ponderous, ſluggiſh, metallic calx, that occaſions inveterate obſtructions, and therefore proves hurtful in putrid fevers. And we know that when iron-filings are taken in female diſorders, where the body is weak, languid, and abounds with acidity, the metal thus produces eructations, as of garlick and putrid eggs, on account of the acid it meets with; and hence, the heat before wanting in the body is excited, and the excrements generally turn black; and in this caſe the powder of iron-filings proves much more ſerviceable, than when ever ſo laboriouſly prepared by chemiſtry. Whence iron is known to prove uſeful if acids abound in the body, but hurtful where the body is bilious or hot. This experiment, duly conſidered, ſhews us the origin of green metalline vitriol every where in the earth; and that it proceeds from iron, corroded by a foſſil vitriolic acid. Laſtly, the production of inks principally depends upon this experiment.

PROCESS CLXIII.

Ludovicus's *vitriol of iron, with tartar.*

'1. TAKE one part of the vitriol of iron, not acid, but perfectly ' ſaturated, four parts of cream of tartar, and twenty parts of ' rain-water; boil them together in a glaſs-veſſel, often ſtirring them with ' a ſtick, till the maſs becomes grey, thick, and almoſt conſiſtent; but with ' care to avoid even the leaſt burning. Put the maſs into a tall bolt-head, ' pour common ſpirit thereon, ſo as to float four inches above it; boil them ' together for an hour or two, and a red liquor will be obtained; when ' cold, decant and filter it. Treat the remainder with freſh ſpirit as before, ' and continue to do this ſo long as the ſpirit acquires any redneſs; then ' put the ſeveral parcels together, which thus make *Ludovicus*'s medicated ' tincture of iron.

' 2. If the tincture, thus prepared, be evaporated to a pellicule, it loſes ' its ſpirit, and afterwards ſhoots, along with the ſalt of iron, into medi' cated cryſtals. And if what remains after boiling with the ſpirit, be

' ſtrongly

'strongly boiled with ten times its quantity of water, and strained thro'
'flannel, till the liquor becomes clear, and all the matter be dissolved by the
'frequent addition of fresh water, and this liquor be at length exhaled to
'a pellicule, and set in a cool, quiet place; we shall thus again have the
'opening martial tartar of *Ludovicus*.'

The use.

Physicians having observed, that the excellent medicinal virtues of iron, somewhat explained in the preceding process, had their effect so long as the iron continued dissolved in a mild acid, but vanished, and were precipitated into an unctuous calx, upon meeting with an alcali, hence prudently joined the salt of iron with a vegetable acid, in expectation that it might thus pass and act upon all the vessels of the body, whilst it more permanently retained a saline nature; and this was the reason of joining the salt of iron with the vegetable oily salt of tartar, to prevent its being easily precipitated in the body into a croms, or astringent calx. The preparation has the virtue of opening, attenuating, strengthening, and gently evacuating by the belly and kidneys; and hence proves curative in leucophlegmatic, scorbutic, icteric, hypochondriacal, and hysterical cases, or when the body is relaxed, weak thro' the sluggishness of the parts, rickety, or abounding with worms.

It is taken in a morning fasting, in the quantity of a drachm, diluted with six times its weight of water, repeating it thrice, and each time drinking after it a quarter of a pint of thin whey, walking gently upon it, so as not to sweat; this may be continued for nine days, with great advantage. A few drops of it may be given to children troubled with the rickets or worms, (and thence become of a bad habit) mixed with syrup or honey. A drachm of the calybeated tartar, taken in the morning, answers the same purposes. And hence we see the method of converting metals into medicines, and forms fit for taking; but they are afterwards prudently to be employed: these are found to have very good effects, if they prove gently purgative, and bring away the fæces of a black or grey colour.

PROCESS CLXIV.

The white, grey, and red calx of the vitriol of iron.

'1. TAKE half an ounce of dry and good vitriol of iron, reduced to
'powder in a glass mortar, apply it in a glazed dish to a heat of
'a hundred and fifty degrees, keeping it continually stirring with a stick;
'a litle watery vapour will fly off, and leave a light white powder, like
'meal, of an inky, sweet, styptic taste: this is the white calx of the vi-
'triol of iron. 2. If this calx be urged with a stronger fire, of near
'three hundred degrees, it will become of a greyer colour, and of a more
'austere taste. 3. If this second calx be calcined in a crucible, in an open
'fire, it grows yellow, red, and at length becomes a deep purple powder,
'of an austere taste, and somewhat caustic; which two properties are the

'more

'more increaſed, the ſtronger the fire, and the longer the calcination; ſo
'that at length the powder will become almoſt cauſtic.'

The uſe.

Hence we ſee that vitriols, or metallic ſalts, preſently loſe their tranſparency, upon loſing their water, and fall as it were into aſhes; whence this operation is called calcination, and the thing produced a calx. And when urged with a ſtronger fire, they no longer remain ſoluble in water, as conſtantly appears in the third calx. The firſt is recommended in medicine, becauſe it retains its native virtue, may be eaſily mixed with ſugar, and thus commodiouſly given to children. It is uſually imagined, that the ſuperabundant acid may be driven away by this calcination; but oil of vitriol does not riſe with ſo ſmall a heat. The ſecond calx has the like virtues, but is ſomewhat more aſtringent, and leſs ſoluble in water: but the third is not ſoluble in the body, yet endowed with a cauſtic virtue, ſo that it can ſeldom be given internally with ſafety. Externally applyed, it is excellent for eating down, and afterwards conſolidating the lips of ulcers; it ſtops fluxes of the lympha, blood and ſerum: but if this red calx of vitriol be long detained in a violent fire, and afterwards boiled in water, it impregnates the water with a vitriolic ſharpneſs. If the operation be continued till the laſt water comes off taſteleſs, an inſipid, red, aſtringent powder, called *crocus martis aſtringens*, will remain behind; and is the body of the iron calcined by acid and the fire; and therefore commonly uſed for aſtringing. The acid waters being evaporated to a pellicule, then ſet to ſhoot, afford ſomewhat of a vitriolic ſalt.

PROCESS CLXV.

The liquor of iron per deliquium.

'IF the red calx of the preceding proceſs be not waſhed with water,
'but ſtrongly calcined, ground fine, put into an open glaſs, and expoſed
'to the moiſt air, it relents, and at length diſſolves into a kind of liquid
'red matter, that may be called the oil of iron *per deliquium*.'

The uſe.

The vitriol of iron contains a very acid foſſil and water, ſo that the water being ſeparated by fire, the ſtrong and pure acid remains dry, along with the metallic part alone; but the acid, being attractive of moiſture, relents by the water of the air; and this is the true reaſon of the effect: the like obtains in all ſimilar caſes. The metals thus diſſolved, in their reſpective acids, then dried, moiſtened in the air, dried again, are thus by repeated operations at length wonderfully opened, reſolved, and even made volatile. The calx of the metals, thus diſſolved by the moiſture of the air, has the ſame virtue as the calx above explained.

PROCESS CLXVI.

The golden tincture of the vitriol of iron.

'TO a quantity of the red vitriol of iron, prepared according to the third operation of the hundred fixty-fourth procefs, made perfectly dry, and put into a tall bolt-head, pour twenty times its weight of dulcified fpirit of fea-falt; digeft for a month, and thus a gold-coloured, fweetifh, ftyptic, inky liquor will be obtained. If this be decanted, and new fpirit put on, and the operation be thus feveral times repeated, the metallic powder will at length remain exhaufted, and all the tincture be thus extracted.

The ufe.

This experiment fhews that confiderable tinctures may be extracted from metals, without diffolving their bodies; for this is a true tincture of iron, fince one drop thereof has an incredible power of producing a black colour, as we fhall fee in the appendix to our courfe of proceffes. But this fpirit can never diffolve all the calx, only extract its more foluble part. A few drops of this liquor, being taken in *Spanifh* wine, upon an empty ftomach, are reftorative, kill worms, and raife the vital powers. The chemical *Magi* placed their medicated gold in iron; poffibly, therefore, this may be their medicated *aurum potabile* (*a*).

PROCESS CLXVII.

Iron diffolved in Rhenifh wine.

'PUT two ounces of bright iron-filings into a bolt-head, and add thereto twenty ounces of generous *Rhenifh* wine; digeft them together in our little wooden furnace, for three or four days, often fhaking the glafs: let them afterwards ftand to fettle for twenty-four hours, ftrain off the wine, which will appear black, and keep it in a clofe ftopped veffel; it is of a fweetifh inky tafte: pour frefh wine on the remainder, and proceed as before; thus alfo a calybeate wine will be obtained, but no way comparable to the former; for the particular part hence obtainable is foon extracted from the iron by the wine; the whole body of the metal not being here diffolved: fo that the production is not a folution, but a tincture.'

The ufe.

Hence it appears, that iron contains one part which is foluble, and another that is infoluble in this mild, fermented, oily, vegetable acid. The former part is the nobleft remedy I am acquainted with, for promoting that power in the body by which the blood is made, as often as it happens to

(*a*) See *Tachen. Hippoc.* pag. 11. and *Bafil. Valent. de hac tinctura.*

be weakened, thro' a bare debility of the over-relax'd ſolids, and an indolent, cold, aqueous indiſpoſition of the juices. If an excellent medicinal virtue may, by any experiment, be gained from metals, certainly it is this; for no virtue of any vegetable or animal ſubſtance, no diet, nor regimen, can effect that in this caſe, which is effected by iron: but it proves hurtful where the vital powers are too ſtrong, whether this proceeds from the fluids or ſolids. I have often thought whether this was not the potable ſulphur of the metal, that ſo powerfully reſiſts the debility of nature; a medicine infinitely ſuperior to the boaſted *aurum potabile*, and a medicine that never proves pernicious when given where required. Hence we ſee that iron has a part not very remote from a vegetable, and even an animal nature; and which is extremely eaſy to diſſolve. If a drachm of this chalybeate wine be mixed with thrice its weight of ſugar, boiled to a proper conſiſtence, and be prudently given in the proper caſes, it makes an incomparable remedy for the young of both ſexes.

PROCESS CLXVIII.

Iron diſſolved in vinegar.

'PUT an ounce of clean iron-filings into a tall bolt-head, and pour 'thereto twenty ounces of the ſtrongeſt diſtilled vinegar; boil them 'together in our little wooden furnace for twenty hours, and when cold, 'there will be obtained a highly red, and ſtyptic liquor, nauſeouſly ſweet'iſh, and thicker than that made with wine in the preceding proceſs. This 'being filtered makes the aſtringent tincture of iron, and ſtains the glaſſes 'wherein it is kept, ſo as ſcarce poſſibly to be got off again. If freſh vine'gar be poured upon the remainder, it again extracts ſome tincture, but 'leſs, and of a weaker colour than before, tho' ſtill chalybeate. At laſt, 'there is left a conſiderable quantity of metallic matter, that can be no far'ther diſſolved by vinegar.

The uſe.

It is ſurpriſing there ſhould be ſo great a difference between the tincture of iron prepared with vinegar, and that with wine, both in regard to colour, taſte, odour, conſiſtence, and effects. It is hence plain, that iron may eaſily, and in very different methods be diſſolved by acids. This ſolution of iron by vinegar is wonderfully aſtringent, and therefore corroborating, and good againſt worms; though not to be every where raſhly employed: it proves more agreeable, if mixed and taken with ſugar. Hence we ſee how eaſily iron diſſolved may enter the human body, and how often, ſince iron is daily treated and diſſolved by acids, and the ſolution drank down; and hence, poſſibly, by inſinuating into the humours, it may contribute to generate the ſtone in the bladder, as Dr. *Liſter* conceived. Thus much is certain, that iron grows almoſt every where, is daily conſumed, riſes out of the earth, and returns to it again. If any metal be changeable, or deſtructible, it is certainly iron.

PROCESS

PROCESS CLXIX.

Iron sublimed with sal-ammoniac.

'TAKE four ounces of bright iron-filings, and as much dry flowers of 'sal-ammoniac, grind them together in a glass mortar, the longer 'the better. Tho' these two bodies were separately inodorous, there now 'presently rises from them a volatile, subtile, and, as it were, an alcaline 'vapour, because the acid of the sal-ammoniac is attracted into the iron; 'whence the volatile alcaline part of that salt, beginning to be set free, sponta-'neously flies off. Let a capacious and dry glass-body be at hand, with a wide 'mouth; put the powder into it, that it may lye thin spread at the bottom. 'Lute on an alembic-head, with a common mixture of meal, apply a receiver, 'set the body in a sand-furnace, and bury it up to the lower rim of the 'head: first make a fire of two hundred and twenty degrees, and there will 'come over a sharp vapour that condenses into a highly penetrating, vola-'tile, alcaline liquor. When no more ascends with this degree of heat, raise 'the fire, that the alembic-head may grow hot; white exhalations will now 'rise, and afterwards others of various colours; the whole cavity of the 'head will be covered with mixed variegated colours, white, red, yellow, 'green, blackish, so as to represent various flowers, from whence the pre-'parations take their name. Proceed with the same degree of fire for six 'or eight hours, then let all cool, and there will be found in the receiver a 'gold-coloured, volatile, alcaline and highly penetrating liquor, along with 'a little white and yellow matter. In the alembic-head and its pipe will 'be found a very subtile and dry matter of various colours; this is imme-'diately to be taken out, and put into a dry and hot glass, to be kept care-'fully stopped; for it would soon dissolve by the moisture of the air, and 'then run into a gold-coloured, fattish, austere, saline liquor. In the first 'dry form, it is called the flowers of iron; and in the latter moist one, the 'oil of iron *per deliquium*. The same matter of the flowers every where 'sticks to the sides of the body, tho' it is here more compact, and as it were 'melted, and runs strong together by the greater force of the fire: this 'also is to be taken out and kept dry. At the bottom of the body there re-'mains a brownish-red matter, of a very austere taste; this matter attracts 'moisture, and presently resolves in a humid air, and runs into a thick, 'gold-coloured, astringent liquor, which is another metallic oil *per deli-'quium*. This matter usually swells greatly upon being exposed to the air, 'and thus resembles some kind of fermentation; but the flowers and this 'remainder differ in many respects.

The use.

Sal-ammoniac consisting of the spirit of sea-salt, and the volatile alcali of animals, being here ground with the iron, unites some part of its acid with the metal; at the same time letting go some part of its alcali, which therefore becomes volatile; the other part of the sal-ammoniac retaining its

nature, and remaining mixed with the iron, now corroded by the acid, ſeparates a particular part of the iron, which is otherwiſe fixed in the fire, and carries it up. But it is not ſo eaſy as ſome write, to ſublime all the ſubſtance of iron by means of ſal-ammoniac; but it here ſeems to be divided into a more volatile part, that riſes, and another more fixed part, that ſtays behind; at leaſt, it appears thus to me; whence I conceive the iron is thus ſeparable into different parts. Hence alſo we may underſtand the particular volatility of ſal-ammoniac, which is able to ſublime a metal, naturally ſo fixed, and ſo hard to melt, as iron; whence the philoſophers have called this ſalt the rapacious bird, the white eagle, and the key that unlocks the bodies of metals. Theſe flowers have the ſame virtues as Mr. *Boyle* commends in the *ens veneris*; for they are a wonderfully reſtorative, warming and opening medicine, containing the open body of the metallic ſulphur. They have alſo an anodyne virtue, and are often ſomewhat ſoporiferous. The dry flowers, being digeſted with alcohol, afford a copious golden tincture, both metallic and ſulphureous; and the remaining *caput mortuum*, after the ſublimation, affords the ſame with alcohol. The curious and induſtrious expoſe the remaining body of the iron and ſalt to the air, where it reſolves; then they coagulate, and inſpiſſate it, and repeat the operation, till at length they ſo wonderfully and deeply diſbowel the metallic maſs, as not to repent their trouble and expence. What chemiſt is ignorant of that rule, ſo often inculcated, diſſolve and coagulate? but whether by repeating this operation, mercury might be obtained from the reſolved body of metals, is another queſtion. I have tried it, tho' without ſucceſs; but the experiments upon metals, by means of ſal-ammoniac, are of infinite uſe.

PROCESS CLXX.

Extraordinary effects upon applying iron to ſulphur.

' 1. TAKE of iron-filings, and flowers of ſulphur, each an ounce, ' grind them together in a glaſs mortar, the longer the better; ' they will thus grow hot, and ſmell ſtrong; then boil the powder in water ' for half an hour, pour off the water, ſtrain and reſerve it; treat the re-' mainder as before: the ſeveral waters, when put together, will taſte ' ſomewhat inky, and when inſpiſſated, leave a little pure vitriol of iron ' behind.

' 2. Take eight ounces of the like mixture of iron and ſulphur, make it ' up into a thick paſte with water, ſqueeze this paſte ſtrongly into an ' earthen pot, and ſet it by; it will ſoon ſpontaneouſly begin to grow hot, ' ſend out fumes, and at length often takes fire. When the heat is over, ' the matter will be found changed into an uniform maſs; which being well ' ground, and boiled with water, as in the former caſe, affords a pure vitriol ' of iron for medicinal uſe.

' 3. Melt ſulphur over the fire, and plunge the end of an iron rod into ' it for ſome time; the part, ſo plunged, will thus become calcined and ' brittle. In the ſame manner, if iron-filings be put into melted brimſtone,

' a *crocus*

'a *crocus* of iron, may be obtained, which, when ground to powder, be-
'comes almoſt the ſame thing.

'4. If ſulphur be thrown upon red hot iron, it makes the iron preſently
'run into calcined metallic drops, which alſo, when ground, afford the like
'calx.'

The uſe.

In theſe four experiments the highly acid oil of vitriol, which makes one part of the ſulphur, coming by means of trituration, or fuſion, to touch the metallic part of the iron, in numerous ſurfaces, it begins to act thereon, after the ſame manner as in the hundred ſixty-ſecond proceſs; forſaking its oily part, and uniting with the iron. And as this action always generates a violent heat, it is no wonder if at length it fires the other oily part, which is eaſily inflammable, eſpecially if the quantity were large, ſufficiently compact, thoroughly ground, and cloſe compreſſed (*a*). And as ſoon as by any of theſe ways, the acid of the ſulphur has corroded the metal, a pure vitriol of iron is produced; becauſe there is no metallic foulneſs in the flowers of ſulphur: and by this means artificial chalybeate mineral waters may be truly produced. Theſe powders are called *crocuſſes* by the chemiſts, on account of their colour, and are of the aperient kind, as having an aperitive, vitriolic virtue; whereas other powders, prepared by the means of acid and fire, are called aſtringent. And thus I think myſelf to have ſhewn, by means of the ſeveral proceſſes from the hundred ſixty-ſecond to the preſent, the principal ways whereby iron is ſo changed, as at length to afford preparations always of very different forms, and ſometimes ſuch as the metal would not have afforded by the means of fire, or any thing elſe, beſides what we applied. But particular metals require particular treatments; in which reſpect a variety of operations is required.

PROCESS CLXXI.

The calx of lead by the vapour of vinegar.

'TAKE a large glaſs-body, cut ſo as to have a very wide mouth, with
'an alembic-head anſwering to it; in this head put thin plates of
'lead, ſo as to ſtand ſomewhat erect, without falling, all around the hol-
'low part of the ledge. Put vinegar into the body; ſet it in a ſand-heat,
'put on the head with its lead-plates, apply a receiver, and diſtil with a
'gentle fire for twelve hours; then leave off, and let all cool for twelve
'hours: the plates, being now gently dried, grow white, or appear co-
'vered with a white powder, which being bruſh'd off with a hare's foot is
'called ceruſe, or white-lead. If the operation be ſeveral times repeated,
'the whole body of the lead will be turned into the like perfectly inſipid,
'ſcentleſs white powder: the vapour of the vinegar, raiſed in the operation,
'condenſes into a whitiſh, turbid, ſweet, nauſeous, ſtyptic liquor, called the
'vinegar, or ſolution of lead.

(*a*) See *Memoir de l'Acad. Roy.* vol. II. pag. 52.

The

The use.

Hence we fee how eafily lead is diffolved by a very mild acid, and foon changed from its malleable ftate into a loofe powder, or brittle fcaly plates. But the diftilled liquor, impregnated with diffolved lead, is a true folution of lead, which being infpiffated affords the true falt of lead. This operation is continually made in lead expofed to the air, that abounds with acids; whence coverings of lead, that are expofed thereto, refolve into a white calx; and this the fooner, the more the air abounds with acids. If the fame operation be performed upon iron or copper, thefe metals alfo are diffolved on their furfaces; the iron into a red calx of iron called ruft, and the copper into a green fubftance, called verdigreafe; the iron into a gold-coloured liquor, and the copper into one that is perfectly green. The cerufe, thus prepared, is likewife compounded of the acid of vinegar, and the diffolved body of the lead; but the acid is here latent, after the fame manner as we faw in iron. This cerufe is of ufe in watery, ulcerous, running fores, or difeafes of the fkin, being fprinkled thereon. If this fine powder be drawn along with the breath into the lungs, it caufes a violent, and almoft incurable or mortal afthma. If received into the mouth, and fwallowed along with the fpittle, it occafions inveterate diftempers in the *vifcera*, intolerable faintings, weaknefs, pains, obftructions, and at length death itfelf. Thefe terrible effects are daily feen among thofe who do any work in lead, but principally among the makers of white-lead. Let men, therefore, beware of this poifon, which, being both without fmell and tafte, proves the more pernicious as it is the lefs difcovered, and does not fhew itfelf till it has deftroyed the body. Hence we learn, alfo, how eafily lead may be demetallized, and turned to a calx; and this appears upon all experiments. If lead be melted over a gentle fire, in a clean unglazed earthen veffel, it runs pure, like clean quickfilver, but foon grows dark upon its furface, and gathers a fkin, which, being carefully taken off with an iron ladle, proves a kind of calx: now, again, the furface appears white, and again generates a fkin that may be taken off, till at length the whole body of the lead is changed into this calx, which alfo is poifonous. This calx, and the former cerufe, being long calcined, and ftirred over the fire, at length increafe in weight, and turn of a bright red colour: and the like is found of lead-ore long-calcined. In the fmelting of copper there rifes a fcum, which chiefly confifts of lead; and if of a colour betwixt red and yellow, it is called litharge of gold; if paler, the litharge of filver; tho' both of them are nearly the fame thing, and of the fame virtue: lead-ore does not much differ from the former. Hence the fame lead may exift under various colours, gravities, maffes, and forms, and may be diffolved in the fame liquors, and thus afford the fame productions; nor is it of much fignificance, whether cerufe, litharge, red-lead, or lead-ore be thus corroded by vinegar; for in each cafe the fame falt of lead is produced: they have all of them the fame medicinal drying virtue, and poifonous quality. Red-lead gains confiderably in weight from the fire. This may, perhaps, be owing to the acid of the fewel imbibed by the lead from the fire (*a*).

(*a*) See Abr. *Boyle*, vol. II. p. 390. §. 7.

PROCESS

PROCESS CLXXII.

The vinegar of lead.

'1. BOIL cerufe in a tall bolt-head, with twenty times its weight of
' ftrong diftilled vinegar, in our little wooden furnace, often fhak-
' ing the veffel for four hours; then let all cool, ftrain off the pure liquor,
' add more diftilled vinegar to the remainder, repeat the operation as be-
' fore, and continue thus till the cerufe is almoft diffolved; mix the feveral
' folutions together; they will be found to have loft the fharpnefs of the
' vinegar, and to have become fweet, naufeous, and ftyptic: this is called
' the vinegar of lead, as alfo virgins milk; becaufe it cures red fpots, pim-
' ples, and little ulcers in the face. If this vinegar be filtered, and diftilled
' with a gentle fire to a fourth, there comes over a naufeous water, that is
' not acid, but of a difagreeable and particular odour. All the acid of the
' vinegar is retained below, in the refolved cerufe. Let it be preferved
' under the title of vinegar of lead; and it is to be efteemed of the fame
' virtue as the vinegar of litharge.

' 2. If inftead of cerufe we take the litharge of gold, or filver, red-lead or
' lead-ore, reduce them to powder, and boil them with vinegar as above;
' they will all afford the fame undiftinguifhable vinegar of lead. This only
' is particular of it, that when cold it filters with difficulty, as then blocking
' up the paper; but when hot it runs thro' eafier.

' 3. When frefh diftilled vinegar is poured to this infpiffated folution,
' and boiled, and again reduced almoft to the confiftence of honey, the
' vinegar diftilled off lofes much of its acid virtue, leaving the acid part in
' the metallic liquor; the part that floats above, being fomewhat oily, unc-
' tuous, and faccharine, is called by the name of oil of lead, and confifts of
' the metal and the vinegar. The oftner this addition of vinegar is repeat-
' ed, the more unctuous the liquor becomes, and the harder to dry.

The ufe.

Hence we have a new method of calcining, and diffolving a very ponderous metal, and bringing it into a liquor. Here we fee a new tafte and odour produced, by acid and metal; and an attraction and feparation of the acid by the metal, till it is fully faturated, and impregnated. This vinegar of lead long preferves uncorrupted the bodies of animals that are plunged therein, or penetrated, and dried therewith; it coagulates the animal juices, and preferves them from putrefaction; if diluted and rubbed upon the fkin, it cures breakings-out, rednefs, inflammations, and the eryfipelas; it gives a whitenefs and beauty to the fkin, but proves pernicious to the body; at length occafioning a confumption, as appears by many melancholy examples. If the infpiffated oil of lead be mixed with an equal quantity of oil of rofes, it makes a white balfam, highly commended by the furgeons.

PROCESS CLXXIII.

The salt of lead with vinegar.

'1. INSPISSATE a quantity of the vinegar of lead in a low glass-body, with a very wide mouth, till it becomes almost as thick as oil; set it in a quiet cold place, and a whitish grey mass will shoot to the bottom, in small, erect spiculæ; pour off all the liquor, and with a gentle fire slowly dry the remainder, which will now be white like sugar, and is called the sugar of lead.

'2. Dissolve this sugar of lead in fresh and sharp distilled vinegar; let it stand to depurate; inspissate the liquor to the thickness of oil; set it in a cold quiet place, and there will shoot at the bottom thick solid crystals, perfectly resembling the form of vegetable candy-sugar, and having nearly the same taste.

'3. If these crystals be again dissolved in fresh distilled vinegar, and the solution be depurated by standing, then inspissated by a soft fire to the thickness of oil, a liquor will be obtained which can hardly be dried, and rendered hard by a small fire, but it remains somewhat fixed, and may be liquified like wax, with a gentle heat. The oftner this impregnation is repeated with fresh vinegar, and the matter dried, the more fixed it becomes in a small fire, so as not to smoke, but easily run. If now it be committed to a moderate heat, and afterwards suffered to cool, but whilst it remains fluid, it be poured into another cold vessel in the cold air, it strongly coagulates in the pouring, and concretes into fine threads like cobwebs, perfectly resembling silver-thread, and affording a very agreeable sight. This was published as a secret by a Jesuit, tho' somewhat disguised in the delivery (*a*).

'4. As soon as this body, coagulated into threads, is exposed to a greater heat, it presently runs again, so that it may again be poured out. And if this resolution and inspissation be carefully and patiently repeated, each time separating the fæces, and then if the matter be long digested with a gentle heat, till it grows thick, and concretes, a mass is at length formed, which to the unwary eye resembles silver. *Isaac Hollandus* deserves to be read upon this subject, where he speaks concerning the stone from lead. The process also may be continued at pleasure, by those who desire to see unusual appearances of bodies.'

The use.

The production is called the sugar, salt, magistery or vitriol of lead. It shews how a fermented vegetable acid may be combined with lead, into a substance soluble in water. It is astringent, styptic, and presently coagulates the blood: being dissolved in water it affords the vinegar of litharge, good against inflammations, when externally used. Internally it is recommended

(*a*) *Lowth.* Abridg. of Philos. Transact. vol. III. p. 325.

for

for a fafe remedy againft fpitting of blood, bleeding at the nofe, making bloody urine, the *gonorrhœa*, the *fluor albus*, and the like, as alfo for a mollifying remedy againft the acrimony of the blood; but I never durft make trial of it, becaufe I never faw it fuccefsfully ufed by others; and becaufe I know there is fcarce a more deceitful and deftructive poifon than this lead, which prefently returns to cerufe, as foon as the acid is abforbed from it, by any thing it may meet with; whence it afterwards proves an exceeding dangerous and almoft incurable poifon to the body. If the falt of lead be gradually diftilled in a retort, and at length urged with a violent fire, there comes over a fat inflammable fpirit, perfectly changed from the nature of the vinegar employed; and there remains at the bottom a fubftance like glafs, which, when urged by a ftrong fire, penetrates almoft all the veffels that are known, vitrifying all bodies, and carrying them thro' with it, except gold and filver.

PROCESS CLXXIV.

The falt of lead with fpirit of nitre.

'1. PUT an ounce of granulated lead, cerufe, litharge, or red-lead, into ' a tall bolt-head; pour thereon fifteen ounces of fpirit of nitre, or ' *aqua fortis*, diluted with ten times their weight of water; there arifes a ' great ebullition with a white froth; which being over, fet the glafs in our ' little wooden furnace to boil for five or fix hours. Let the liquor reft, and ' cool, then filter it, and diftil it to a pellicule; a naufeous but not acid water ' will come over; put the remaining liquor in a cold place, and there will ' fhoot white, folid, and very ponderous cryftals, that do not run in the air, ' but continue folid; they are of a fweetifh tafte, and more auftere than thofe ' of the preceding procefs: the liquor alfo, after the folution, or both before ' and after the cryftallization, has a faccharine fweetnefs, like the falt. 2. If ' frefh *aqua fortis* be poured to this falt, fo as to diffolve it, and the liquor ' be again infpiffated, an oil of lead may thus alfo be prepared, which coagu' lates with difficulty, but gradually fixes, fo as to run like wax, with a ' gentle heat. 3. This falt being dried, and thrown upon live coals, does ' not take flame, but crackles violently in the fire, and flies all around, with ' great danger to the by-ftanders; but if reduced to fine powder, it may ' be melted in a ftrong fire.

The ufe.

Hence we have a new method of producing a metallic falt, and its oil; a fweet tafte, from an acid and an infipid body; a glafs from a metal; and of fhewing that fpirit of nitre will not make an inflammable falt with every metal, as it does with filver. The falt here has the fame virtues as that of the preceding procefs, but is more fharp and aftringent.

PROCESS CLXXV.

The ſalt of lead treated with alcalies.

'TO two ounces of the cryſtalline ſalt of lead, made according to the
' hundred ſeventy-third, or hundred ſeventy-fourth proceſs, tho-
' roughly dried, and reduced to fine powder, add four ounces of oil of
' tartar *per deliquium*; ſet them in digeſtion, where the longer they ſtand
' the better; then add an ounce of ſal-ammoniac, mix them well, and di-
' geſt again in a cloſe veſſel; pour back the ſaline liquor that comes over
' in the digeſtion, and digeſt again; which being twice or thrice repeated,
' thoroughly dry the matter by a gentle fire, and expoſe it to a moiſt air,
' that it may diſſolve; dry it again, and diſtil it in a coated glaſs-retort,
' with degrees of fire to the higheſt that ſand will give, into a large receiver,
' containing a little fair water. Three kinds of matter will thus come over,
' which ſeems ſurprizing, whilſt another of a particular nature, and ſtrange-
' ly changed, remains at the bottom of the retort.

The uſe.

Many very particular things are learnt from this experiment, and ſuch as are pleaſant to behold; for the metal thus ſucceſſively opened and diſſolved by oppoſite ſalts, then coagulated and diſſolved in the air, is highly changed, opened, ſubtilized, divided and ſeparated from all that which is not purely mercurial or metallic, and may thus exhibit its pure metallic mercurial part, ſeparated from the reſt; if the induſtry of the operator can reach ſo far.

PROCESS CLXXVI.

The calx of the vitriol of lead.

'TAKE the vitriol of lead, made according to the hundred ſeventy-
' third, and hundred ſeventy-fourth proceſſes, dry it thoroughly
' with a gentle fire, grind it to fine powder, put it into a glazed earthen
' diſh, ſet it over the fire, and keep it continually ſtirring with a tobacco-
' pipe, till it yields no more fumes with a great heat; a fine, and almoſt
' inſipid powder will thus be obtained, which is another calx of lead, made
' in the moiſt way.'

The uſe.

All the acid which was united with the lead, in the form of the vitriol of lead, is here again ſeparated from it by the fire, except that part, which intimately adhering thereto, does not appear externally, and was therefore much more cloſely united with it in this operation.

PROCESS CLXXVII.

The balsam of lead with expressed vegetable oils.

' 1. PUT granulated lead, any calx thereof, ceruse, litharge, or red-lead, ' into a glazed earthen vessel; add to it twice its weight of any ' expressed oil; then gradually raise the fire, and the lead will begin to melt ' at the bottom before the oil boils; but if the fire be gradually increased, ' so as to make the lead boil, the body of the lead, or calx, will begin to ' disappear, and mix so intimately with the oil, as to make a true balsam, ' which, by longer boiling, may be brought to a substance that is solid in ' the cold, semi-metallic, will melt in the fire, and is ductile. 2. If, instead ' of lead, or its calx, we use that calx prepared in the hundred seventy-sixth ' process, or the salt of lead, first dried, and treat it with expressed oil in ' the manner above delivered, the like balsam will be obtained as from the ' true metal, and the oil.'

The use.

Hence we see, that true and very ponderous metals may, by the means of fire, be dissolved in vegetable sulphur, and so mixed, as to lye perfectly concealed therein; whence we are often ignorant whether metals are concealed in certain bodies or not; how wonderfully they may be disguised: and how often they may proceed from matters not thought to contain them; when they have been often falsely supposed to be obtained from them by transmutation: all these particulars admonish us to be cautious of the impositions of the fraudulent alchemists. These emplastic preparations of lead are of use to strengthen and warm the parts, whereto they are applied; they also discuss, mollify, and absorb acrimonious humours; in particular, they are excellent for lining vessels designed to contain water; for if red-lead be boiled in oil to a proper thickness, and be exactly spread over a stone-wall made almost red-hot, so as intimately to penetrate and stick therein, it will cause the wall to resist water, as well as if it was built with cement. This mixture we use to prevent worm-tubs from leaking.

PROCESS CLXXVIII.

The balsam of lead with distilled vegetable oil.

' GENTLY dry the sugar of lead of the hundred seventy-third pro- ' cess, put it into a tall bolt-head, and add to it four times its weight ' of the ætherial oil of turpentine; boil it for some time, which is easily ' done, if the glass, with this mixture, be put into a vessel in which linseed ' oil grows just hot enough for the purpose, which happens long before the ' linseed oil itself will boil; thus the oil of turpentine will almost wholly ' dissolve the sugar of lead, whereby the balsam is obtained.'

The use.

This process has the same use with the former.

PROCESS CLXXIX.

The glass of lead.

'1. MIX two parts of red-lead with one of clean sand, reduced to fine powder, by grinding them long together; then put them into a clean crucible, set in the fire, so that the matter may melt, and continue in fusion for some time, till, when examined by dipping a tobacco-pipe therein, what sticks thereto appears transparent; then pour it out upon a marble; a brittle, yellow, transparent, inodorous, insipid mass will be thus obtained, that proves hard in the cold, and melts in the fire; whence it is called glass of lead. This matter, when fused in the fire, passes thro' all the known vessels, as water thro' a sponge, and converts almost all bodies into glass, with itself in fusion, carrying them thro' the pores of the vessels, except gold and silver. In order to make the mixture of the red-lead and sand sooner run into glass, some add nitre, and others sea-salt, and keep the crucible in the fire till the salt is melted. 2. If the sugar of lead be put into a crucible, and urged with a gentle fire, successively increased, the vinegar flies off, and the matter is so changed, as to run into a yellow glass, at the same time that wonderful, pleasing colours appear in the middle, like those of the rain-bow, or the peacock's tail. 3. If lead itself be long kept melted in the fire, it becomes drossy at top, which increases, till the lead is almost wholly converted into the same kind of matter; and this being again urged with a strong fire, turns of itself into glass: but this is a laborious operation, and requires much caution: the easiest method appears to be the following. 4. Take four parts of red-lead, one part of sand, and two parts of dry decrepitated sea-salt; grind them together, the longer the better; put them into a close-covered crucible, melt them all together, and suffer the whole to rest; the salt will be found melted in a glebe at top, and the glass below, when the crucible is broke, and should be separated from the rest for the purposes of metallurgy, where it is extremely useful. 5. These glasses being mixed with a little powdered charcoal, and melted in the fire, easily turn to lead again.

The use.

We have here a wonderful change of this metal, (by means of fire, and the discharge of a metallic, highly poisonous vapour,) from a perfectly malleable state, to an extremely brittle and true glassy matter. Whence we see how wonderfully, and under what various forms, metals may lye concealed, and how easily they may again appear. And hence, perhaps, metals vitrify in the fire, after being separated from a certain sulphureous part. This seems to appear from the making of the glass of antimony, and other

other experiments. And upon restoring this sulphur, the metallic form begins to return, as we see in many instances, especially in lead (*a*). This glass of lead is the true test of metals, and destroys every thing in the fire, except gold and silver, which it leaves untouched, without any diminution of their weight. And upon this foundation depends the whole art of assaying and refining, which is of so great use in civil affairs: and let thus much suffice for lead. Whoever would know more of the subject, may consult *Boyle*, *Bohn*, *Homberg*, and *Geoffroy*. But let it be carefully remembred, that the fume, the powder, and all the parts of lead are carefully to be avoided, as highly poisonous.

PROCESS CLXXX.

The solution of pure silver in spirit of nitre, or aqua fortis.

' 1. TAKE an ounce of silver, refined with ten times its quantity of ' lead, upon the refiner's test; melt it in a clean crucible, and directly pour it into fair cold water, eight inches high, in a cylindrical vessel; ' the silver falls into it with a hissing noise, and is scattered about in the ' water in grains: it is now called granulated silver. Put an ounce thereof ' into a clean urinal-glass; then take two ounces of *aqua fortis*, put thereto ' a grain of refined silver, and if it be soon perfectly dissolved, so as to leave ' the liquor limpid, the *aqua fortis* was good, and fit for this purpose; but ' if not dissolved, or the liquor appears turbid, the *aqua fortis* is not genuine, or proper for this purpose. The first kind of *aqua fortis* is called ' proof *aqua fortis* by the refiners. Pour two ounces of this proof *aqua* ' *fortis* upon an ounce of granulated silver, contained in the urinal-glass; ' the liquor immediately begins to move, buble, grow warm, fume and hiss ' about the surface of the silver, and then becomes spontaneously hot, briskly agitated, sends out red fumes, and dissolves the silver, so that it perfectly disappears. A transparent colourless liquor is thus obtained, of an ' exceeding sharp, bitter, and caustic taste; a little of a very black powder ' always remains at the bottom of the glass. This powder is pure gold, ' which either always adheres to silver, or else, perhaps, is easily produced ' from the lead in the fire, as Mr. *Homberg* conceives; and being uncapable of dissolving in *aqua fortis*, is thus precipitated from the solution: pour ' off the clear liquor into a clean glass, and intitle it the *Solution of silver*. 2. If, ' instead of *aqua fortis*, spirit of nitre be employed, the solution is performed ' quicker and stronger, but otherwise in the same manner; for *aqua fortis*, ' or spirit of nitre, prepared either with bole or oil of vitriol, scarce seem ' to differ, except in being more or less acid; but if the least particle of ' common salt, or sal-ammoniac, should accidently have fallen into the spirit of nitre, or *aqua fortis*, or have been mixed with them in the distillation, ' or afterwards, they will not dissolve the silver.

(*a*) See *Memoir. de l'Acad. Roy.* an. 1709. p. 218, &c.

The use.

If this solution proves lympid, the silver was pure; but if greenish, it contained some portion of copper, and is not fit for the following experiments: the silver here united with the acid of the spirit of nitre, keeps suspended in the water; a drop of the liquor, applied to any soft warm part of the body, instantly burns and eats it: whence at once touching, it eats down the callous and hard lips of ulcers, separates the corrupted part, and presently takes away marks, spots, warts, and small cancers. It may be diluted with pure water, without growing thick or precipitating; but if the water contains the least saline matter, the whole will presently grow turbid. This solution, well weakened with water, is highly detergent; but stains the skin it touches with a black spot, that cannot be got out, before the scarf-skin falls off. Hence we see how the ponderous body of silver may lye concealed in a light, limpid liquor: but it may be discovered by its violently bitter taste.

PROCESS CLXXXI.

The vitriol of silver.

' 1. TO the solution made in the preceding process, gradually put single ' grains of pure silver, so long as it will dissolve them. When ' the last grain remains perfectly undissolved, set the saturated solution in ' a cold place; it will presently begin to form little, thin, white plates, lying ' over one another, as if composed of triangular needles like nitre. If the ' liquor be poured off from them, we thus obtain the crystals, salt, or vi- ' triol of silver, which may be dried, but are so sharp, that they cannot ' safely be touched. 2. If the former solution be not further saturated with ' silver, but inspissated a little, so as to lose about a tenth part, and then be ' set by for some time, the silver will concrete at the bottom of the glass, ' in a solid form, into white crystals, in other respects like the former, but ' much sharper, as being here saturated with more acid. And these also ' have a much greater caustic virtue.

The use.

We here see the particular, and mutual attraction betwixt silver and the acid of nitre; as silver scarce unites with any other acid: for tho' it turns black, it does not dissolve with them. This vitriol of silver is a most immediate caustic, and leaves a black spot upon any part of the skin it touches ever so slightly; and this spot cannot be got off but by the scaling off of the skin.

PROCESS

PROCESS CLXXXII.

The lunar caustic, or lapis infernalis.

'1. TAKE potters earth that is well wrought, and not very moist, ' make it into a solid cube, and perforate the upper surface thereof ' perpendicularly, with a conical stick, almost to the bottom. Let the ' internal surface of the whole be smooth, lest the matter poured in should ' come out rough. When as many of these holes are made as are neces-' sary, press the upper part of each with the finger, into a wide spherical ' cavity, the middle whereof ends in a conical hole; for thus the matter ' may be easily poured in. 2. Then take a little glass-dish, or urinal-bot-' tom, and put into it the first crystals of silver of the preceding process; ' set the glass, without any fear of breaking, upon burning coals; the cry-' stals will discharge an unctuous fume; which ceasing to rise, whilst the ' matter flows in the glass, pour it carefully into the conical cavities made ' in the cube of clay; it will enter with an hissing noise. If the matter in ' the glass should chance to grow stiff, set it again over the fire; and thus ' pour out all the prepared silver into the hollow moulds. 3. As soon as ' the whole matter is grown solid, immediately break the clay, and take ' out the conical sticks of silver; wrap them up in hot paper, and dry them ' thoroughly therein; then wipe their surface, with a hot and dry hare's ' foot, and thus immediately put them into a clean glass, that is to be well ' stopped with a cork: and thus an excellent *lapis infernalis* will be obtained ' for chirurgical uses, and may be kept perfect for many years.

The use.

The acid of the spirit of nitre, in the glass over the fire, loses its water in the form of fume; and also that part of its acid which remained above what a certain proportion of silver could retain; but the silver detains a certain proportion of the acid with itself, so as not to fume, but remain fixed, even in fusion over the fire: this acid, retained in the body of the pure silver, forms a solid mass, in which, perhaps, the acid is the purest and strongest that can be prepared. When this acid, adhering to the silver in a solid form, is exposed to the air, it attracts the moisture thereof, and so dissolves. The whole of this *lapis infernalis* will also dissolve in water, from whence, by the means of copper, all the silver may be recovered, insipid, inodorous, unactive, no way acid or corrosive, but pure, metalline, and unchanged. It is strange therefore that the acid should so long adhere to the surface only of the principles of silver, without changing them, so as that the nature of the metal may be entirely recovered unhurt. This *lapis infernalis* is a most powerful cautery, and by a bare touch instantly burns the parts of a live body to an escar, under which nature raises an inflammation that separates the crude escar, and leaves the part pure; so that by repeated touches with this matter, all superficial, foul, fungous ulcers and cancers are excellently cured. Hence skilful chirurgeons highly extol the virtue of this stone; and physicians

physicians alſo learn the wonderful power of an acid, when collected and fixed. If given internally in this form, it is an immediate corroſive poiſon; and therefore never to be uſed in this manner. I have known it prove pernicious to the artiſt that prepared it.

PROCESS CLXXXIII.

The ſilver pill of Boyle *or* Angelus Sala.

' 1. TAKE an ounce of pure nitre, and diſſolve it in pure diſtilled ' water; then take an ounce of the pure cryſtals of ſilver, made ' according to the firſt direction, under the hundred eighty-firſt proceſs; ' diſſolve them in thrice their weight of fair water, ſo that the liquor may ' be perfectly limpid; mix the two ſolutions together; they will thus make ' an homogeneous, uniform, and apparently ſimple liquor, without precipi' tating the ſilver, but uniting perfectly with the nitre. Put the pure liquor ' into a clean urinal-glaſs, and ſet it over a clear fire in a place free from duſt, ' till the water, which will thus be almoſt pure, exhales, ſo as to leave a ' pellicule. Set the glaſs in a cold quiet place, well covered to keep out the ' duſt; cryſtals, like nitre, will thus ſhoot. Pour off the remaining liquor, ' and exhale as before; the ſilver and the nitre will be thus joined in the ' ſimple form of cryſtals: let this maſs be gently dried. 2. Let there be at ' hand the bottom part of an urinal-glaſs, into which put the cryſtals of ' ſilver, and nitre, firſt dried in paper; ſet this glaſs on the fire, ſo as to ' prevent the matter from running by the too great heat or nearneſs thereof, ' and permit it only to dry or to fume; keep it conſtantly ſtirring with a ' ſtick of glaſs, ſo that it may every way be expoſed to a ſtrong fire, but ' ſo as not to melt; that it may be dried and freed from the ſharp acid that ' adhered to the maſs, and eaſily rendered it cauſtic; but if the fire ſhould ' melt it, then the acid, being more cloſely united, fixes the corroſive vir' tue, which by this gentle calcination is ſeparated. Let this calcination be ' performed with caution, for a long time, keeping the matter continually ' ſtirred, till no more fume riſes, tho' the fire be now conſiderably ſtrong, ' and almoſt able to melt the matter: for at laſt, after the heat has ſepa' rated all this acid, there is no harm if the maſs be fuſed, becauſe all the ' external acid is now driven from it; and thus the purging ſilver will ' be prepared, of an extremely bitter taſte, and ſhould be kept in a dry ' cloſe veſſel.

The uſe.

It is a wonderful and ſecret art to unite ſilver with nitre: hence the pretended alchemiſts can, by this means, conceal ſilver in a large proportion of nitre, as ten times its quantity for example; and this nitre being projected, in an equal quantity, upon melted lead, gives an increaſe of one tenth part in ſilver, which remaining upon the teſt, will deceive the ignorant, as if a tenth part of the lead was here turned into ſilver. The way to diſcover the cheat is to diſſolve the maſs of nitre and ſilver in ten times its quantity of pure

pure diſtilled rain-water, then put a poliſhed plate of copper into the liquor; for thus every particle of the ſilver will immediately be precipitated to the copper, and bottom of the veſſel, and thus be obtained perfectly pure from the nitre and ſpirit of nitre. If, therefore, any ſalt be pretended to, for the making of ſilver, let it be examined in that manner. Take this dried maſs, conſiſting of the ſalts of ſilver and nitre, reduce it to a fine dry powder, and it will be of an extreme bitter taſte, but by no means ſo cauſtic as before. If a little of it be applied to ulcers, it acts like *lapis infernalis*, only much milder; and if two grains of it be fine ground with ſix grains of loaf-ſugar, in a glaſs-mortar, then mixed with ten grains of the crumbs of bread, and formed into nine pills, and theſe be taken by a grown perſon upon an empty ſtomach, drinking after them four or ſix ounces of hot water ſweetned with honey, they will purge gently, and bring away a liquid water, that often deceives the patient, as coming away almoſt without being perceived. It kills worms, and cures many inveterate ulcerous diſorders; it relieves in the dropſy, and purges without griping; but it muſt not be uſed too freely, nor in too large a doſe, for it always proves corroſive and weakening, eſpecially to the ſtomach; which inconvenience is remedied by the rob of juniper.

PROCESS CLXXXIV.

Inflammable ſilver.

'TAKE an ignited piece of *Dutch* turf, after it ceaſes to ſmoke, place 'it with its upper flat ſurface, parallel to the horizon; make a little 'cavity in the middle of its ſurface, and therein put a drachm of dry *lapis* '*infernalis*, it will here immediately melt, glow, take flame, hiſs, and ſhine 'briſkly in every reſpect as nitre. After the flame ceaſes, pure ſilver will 'be found in the hollow, as much in quantity as was diſſolved in making 'of the *lapis infernalis*, and may thus be taken out with a pair of forceps, 'without loſs of weight.

The uſe.

This excellent experiment ſhews the phyſical manner wherein acids do but ſuperficially adhere to ſilver; and the manner wherein acids operate when united to metals, whilſt ſurrounding their metallic maſs, they arm the ponderous principles thereof with *ſpiculæ*. It ſhews the immutability of ſilver diſſolved in an acid, and the various ways wherein it may lye concealed, yet ſtill have its action; it alſo ſhews the difference of potable ſilver, while exiſting in a ſaline form, by means of an adhering acid, from that potable ſilver of the adepts, where the principles of the ſilver are ſuppoſed converted into a fluid that will mix with the juices of the body, and cannot be reduced to ſilver again; but chiefly it hence appears, that the acid ſpirit of nitre, adhering in a ſolid maſs to the ſilver, is as inflammable along with a combuſtible body, as nitre itſelf. This ſeems to happen in ſilver alone, which is unchangeable, by the ſpirit of nitre. Hence alſo we ſee one way whereby ſilver may be obtained pure from other adhering mat-

ters, by bare burning. The acid here acts neither upon the mercurial part of the ſilver, nor its fixing ſulphur: and many more particulars of this experiment might be enumerated.

PROCESS CLXXXV.

The recovery of ſilver, when diſſolved in ſpirit of nitre.

'DISSOLVE an ounce of pure ſilver in ſpirit of nitre, dilute it with 'twenty times the weight of diſtilled rain water, heat the ſolution in 'a cylindrical glaſs-veſſel, and put therein poliſhed plates of copper, the 'ſmooth ſurfaces whereof will every where begin to be covered with a grey 'colour, and at length appear as if thick ſet with down. The liquor that 'before was aqueous, and colourleſs, will now gradually turn more and 'more green, in proportion as the down upon the copper-plates grows 'larger. If a plate be ſhook, the downy covering falls off from it to the 'bottom, and another like the former preſently comes on; the liquor grows 'greener, and the plates grow leſs. The downy covering being again 'ſhook off, a freſh one grows; and this happens till at length no more of 'the copper diſſolves. Now leave the veſſels for ſix hours at reſt, after'wards ſhake off all the grey-coloured downy matter from the plates; de'cant and filter the liquor; it will be of a beautiful green colour, ſharp, and 'intirely cupreous; the plates will be much diminiſhed in bulk and weight. 'Let the matter at the bottom be waſhed in ſeveral hot waters, till it becomes 'thoroughly pure, then dry it over the fire; it will be a fine ſhining ſilver 'powder, and yield nearly all the ſilver employed, pure, inſipid, and mild, 'without any acid; nor will it contain the leaſt copper.'

The uſe.

This is a method of calcining ſilver to a fine powder, which cannot eaſily be obtained ſo ſubtile by any other means. This powder being ground with mercury, eaſily affords an amalgam, which is otherwiſe ſo difficultly obtained, and not without a great loſs of the quickſilver. If this powder be melted in a crucible, it reſtores the ſame ſilver that was employed. Hence, therefore, it appears how ſuperficially the acid of the nitre adhered to the ſilver, ſince the whole of this acid is ſo eaſily attracted by the copper from the ſilver, without any remainder. If the liquor of this operation be viewed with a microſcope, it appears plainly that little particles of ſilver are violently carried along with the acid of the nitre up to the copper-plates, from all the points of the ſolution. But when theſe *ſpiculæ* arrive at the ſmooth ſurface of the plate, the acid is attracted to the particle of the copper, whilſt the particle of the ſilver, deprived of its acid, reſts upon the ſurface of the copper; and being there increaſed by others coming to it in like manner, at length a ſoft downy caſe is compoſed: and this attraction is ſo exquiſitely performed, that not the leaſt particle of ſilver remains in the former ſolution. Hence it appears, that copper more ſtrongly attracts the acid of nitre than ſilver does; wherefore this action conſiſts in attraction, and a ſtraining

of

of the acid from the body of the liquor; for the acid paſſes thro' the pores of the copper, leaving behind the particles of the ſilver now ſet free, and unable to enter: there is ſcarce a more beautiful ſight than this with a microſcope. The acid of the nitre remains unchanged in the ſilver, and is collected perfect in the copper, from whence it may again be obtained.

PROCESS CLXXXVI.

Luna cornea.

' 1. TO the pure ſolution of ſilver made with ſpirit of nitre, according ' to the firſt direction of the hundred and eighty-firſt proceſs, ' and diluted with four times its quantity of pure water, let fall, by a ' drop at a time, in a capacious glaſs veſſel, a ſmall quantity of a ſtrong ' and warm ſolution of ſea-ſalt in water. At the inſtant the drop falls in, ' the whole liquor grows white and ſurprizingly thick, without any effer- ' veſcence. Continue thus dropping in, and ſhaking the glaſs, till the li- ' quor no longer continues turbid; then let it reſt: a groſs white matter will ' fall to the bottom in a large quantity. Let the limpid liquor at top be ' poured gently off, and drop into it a little hot ſolution of ſea-ſalt; if ' it grows thick no longer, the operation is well performed, but otherwiſe ' ſome ſilver remains behind, which requires to be ſeparated. Pour clean ' hot water upon the white precipitated matter, and waſh it till it becomes ' perfectly inſipid, then boil it in an urinal with a little fair water, ſhake ' them together, and pour the whole into a paper filter, where the water ' will paſs thro' and leave the white matter behind, which is to be dried ' with a gentle fire, and preſerved as the ſubtile calx of ſilver precipitated ' with ſea-ſalt from ſpirit of nitre, or *aqua fortis*; it will weigh more than ' the ſilver employed by nearly a fifth part, on account of the ſalts, which ' adhere thereto. 2. Put this calx of ſilver into a clean crucible, ſet it in a ' fire of fuſion till it melts, which it eaſily does; when melted, pour it out ' on a marble: it appears a ponderous, ſhining, opake, brown maſs, that ' breaks brittle with ſome degree of tenacity, whence it is called horny. It ' contains all the ſilver employed, and at the ſame time the acid of the nitre ' and ſea-ſalt, wonderfully concreted therewith, ſo as not to be eaſily ſepa- ' rated; for by endeavouring with a violent fire to drive away the ſpirit, ' which is ſo eaſily done in the *lapis infernalis*, the greateſt part here be- ' comes volatile, and the remainder is ſcarce recoverable into ſilver, but re- ' mains changed by the admixture of the ſalts, ſo intimately united, and ' fixed, as not to manifeſt themſelves by any ſaline property. If one part ' of pure ſilver, calcined according to the hundred eighty-fifth proceſs, be ' mixed with two parts of mercury-ſublimate and diſtilled in a glaſs-retort, ' with a ſtrong ſand-heat at laſt, almoſt the ſame perfect *luna cornea* will re- ' main at the bottom of the retort. And if inſtead of ſalt, the ſpirit of ſea-ſalt ' were uſed to the ſolution of the ſilver, the *luna cornea* would be perfectly the

 ' ſame,

'same. Mr. *Boyle* says, that silver being precipitated from spirit of nitre with 'oil of vitriol, then washed and fused, will become a true *luna cornea* (a).

The use.

This experiment is of infinite use, and shews how small a difference in a physical circumstance may often occasion a great difference in the thing physically produced; for silver mixed with *aqua regia* does not unite with the acid thereof; but if when silver is dissolved by spirit of nitre, sea-salt is added thereto, tho' it thus only makes an *aqua regia*, yet it presently occasions the acid of the *aqua regia* to unite intimately with the silver, and produce strange effects. For if two parts of the precipitated calx of silver be well ground with one part of regulus of antimony, and distilled with a sand-heat, there comes over a pure butter of antimony, equal in weight to the antimony employed; whilst the silver remaining at the bottom, always affords true gold upon the reduction. Hence we may be certain that the weight gained by the calx of silver, is owing to the *aqua regia* fixed therein, because it here goes into the mercurial part of the antimony; whence it is no wonder, that those eminent chemists *Becher*, *Boyle*, *Homberg*, and *Stahl*, have so much regarded the concealed arsenical nature of the metals and salts in this experiment. Who could conceive that the exceedingly insipid body of *luna cornea* held a fifth part of the highly corrosive acid of *aqua regia?* Hence we see what a particular power sea-salt has upon metals, how covertly it may adhere to, and again be recovered from them without loss of its virtues. Hence also we see how strangely metals may be disguised and concealed; and again, how gold may be obtained from a matter in which the assay-masters could not, by all their art, discover any: and hence the adepts have said, that nature has only placed perfection in salt and gold; and hence we may also learn to guard against the fraudulent practices of those who craftily mix this calx of silver with nitre, or throw it into melted lead, and thus pretend an increase of silver or gold. But our present design does not lead us farther into this subject. It is certain that the industry of Mr. *Homberg*, by the means of tartar, quick-lime, sal-ammoniac, and the white of eggs, has from half a pound of silver obtained, as he declares, three drachms and fifty grains of running mercury: and so much of the nature of silver for the present. *Luna cornea* neither dissolves in *aqua regia*, *aqua fortis*, nor the fire.

PROCESS CLXXXVII.

Tin dissolved in aqua regia.

'1. MIX with *aqua fortis*, or spirit of nitre, a sixth part of sea-salt, or 'sal-ammoniac, or spirit of sea-salt, and thus an *aqua regia* is obtained, which dissolves gold, and not silver. If *aqua fortis* also be drawn off

(a) Origin of forms, p. 203—209. Some mistake here of the author, see Abr. *Boyle*, vol. I. p. 537. §. 9.

‘ from ~~ſea-ſalt~~ nitre, or ſpirit of ſalt from ~~nitre~~ sea salt, by diſtillation, thus alſo an *aqua* ‘ *regia* is obtained. Again, if two parts of nitre, three of vitriol, and five ‘ of ſea-ſalt, be diſtilled together, as in the making of *aqua fortis*, this ‘ affords an excellent *aqua regia*; which therefore we ſee conſiſts of a mix- ‘ ture of nitre and common ſalt. 2. To a quantity of this *aqua regia* con- ‘ tained in an urinal-glaſs, add a little tin, and a violent diſſolution ariſes; ‘ continue till as much tin is diſſolved as poſſible, and the ſolution will ap- ‘ pear thick or oily. If the ſolution be diluted with twenty times its quantity ‘ of water, or more, the tin will be precipitated; which being perfectly waſh- ‘ ed in water, and then dried, affords a white powder, or magiſtery of tin. ‘ 3. Tin, put into *aqua fortis*, makes a violent effervеſcence; when the tin ‘ diſſolving and ſwelling appears in the form of a thick ſoap, or the white ‘ of eggs.

The uſe.

This is a particular manner of ſolution; the liquor is in ſome meaſure bitter, and therein approaches to ſilver. The calx, thus prepared, is given by many phyſicians, as a particular remedy in hypochondriacal and hyſterical caſes; but I do not admire it, as there are ſafer for the ſame purpoſe. When duly mixed with pomatum, it affords a famous coſmetic, in caſe of an ulcerated ſkin. It is difficult, with the utmoſt violence of fire, to reduce it to tin again. It appears by this experiment, that tin of all the metals, diſſolves with the leaſt proportion of acid. It is ſurpriſing that tin, diſſolved in *aqua regia*, does not fume; yet if mixed with twice its weight of mercury-ſublimate and diſtilled in a retort, it affords a liquor at firſt that will ſmoke perpetually, and exhale all away.

PROCESS CLXXXVIII.

Copper diſſolved in diſtilled vinegar.

‘ 1. IF plates of pure copper be put into a glaſs alembic-head, and treated ‘ as the plates of lead under the hundred ſeventy-firſt proceſs, the ‘ diſtilled vinegar will come over in form of a green liquor; ſo that if ‘ the operation be long enough continued, all the metal will be thus diſ- ‘ ſolved. The liquor ſo prepared and filtered, being inſpiſſated over a ‘ gentle fire, becomes green like an emerald; and the leaſt part of a drop ‘ proves vomitive. It is of an ungrateful nauſeous ſmell. The plates being ‘ dry, afford a ruſt or *crocus* of copper, but not the true verdigreaſe, which ‘ is only made at *Montpellier*, by a very particular treatment of copper-plates ‘ with the vapour of red wine, that has been digeſted with the huſks of grapes ‘ after preſſing. Hence this latter menſtruum is ſcarce acid; but oily, fat, ‘ and unctuous. 2. If the common verdigreaſe be put into a bolt-head, and ‘ boiled with pure diſtilled vinegar, till a tincture is procured, and this being ‘ poured off, and new vinegar added, and the whole proceſs repeated, till ‘ the laſt vinegar be no longer tinged, there remains a large quantity of ‘ inſoluble matter at the bottom, which ſhews that it is not diſſolved copper alone

'alone that makes this verdigreaſe. All the tinctures being filtered, and 'diſtilled, till only one fourth remains, afford a ſtrong ſolution of copper, 'that ſhoots into green cryſtals, which, when too dry, and deprived of 'their acid, turn black. See Proceſs 53.

The uſe.

This proceſs ſerves to ſhew the ſolubility of copper, the origin of its ruſt, verdigreaſe, and the blackneſs that eaſily tarniſhes copper; with the way of diſcovering copper concealed in ſilver, by the greenneſs it eaſily communicates to acids. The ſolution is of a wonderful emetic and purgative virtue: watery, ſpongy, running, ſanious, virulent ulcers, being touched with this liquor, are quicken'd, contracted, dried, and cleanſed.

PROCESS CLXXXIX.

The ſolution of copper in ſal-ammoniac.

'MIX three parts of ſal-ammoniac with one of pure copper-filings, 'add four parts of fair water, in a cut glaſs body, dry the whole to 'a paſte by a gentle fire, and again diſſolve it in the air: repeat the proceſs 'ſeveral times, by which means an almoſt entire ſolution of the copper 'will be obtained. Then boil the mixture with water; filter, and inſpiſſate 'the liquor a little, which will thus become a pure tincture; and if artifi-'cially cryſtallized, it affords beautiful ſaline cryſtals of copper.'

The uſe.

Hence we ſee the relation betwixt ſalts and copper. The liquor, here obtained, is a famous anti-epileptic for children; a few drops of it given in mead, upon an empty ſtomach, and followed with gentle exerciſe, purges a little, gives a *nauſea*, but wonderfully improves and excites weak and relaxed ſtomachs, carries off water, and kills worms; and by this means proves curative in certain kinds of ill habits, and the epilepſy.

PROCESS CXC.

Copper diſſolved in aqua fortis.

'PUT common *aqua fortis*, or ſpirit of nitre, into an urinal, and by 'degrees throw in a little fine filings of pure copper; there immedi-'ately ariſes an ebullition with red fumes; all the liquor inſtantly appear-'ing of a beautiful green. Continue thus, till the laſt part thrown in does 'not increaſe the greenneſs; let the liquor be purified by ſtanding, and by 'filtering, and afterwards inſpiſſate it to an half.

The uſe.

Hence we learn the action of ſpirit of nitre upon copper. The ſolution is emetic in a ſmall doſe: it kills all inſects, and if largely diluted with water,

it readily deſtroys lice, fleas, and crab-lice; in ulcers it has the ſame effects, as above-mentioned, of copper diſſolved in vinegar, but requires to be cautiouſly uſed.

PROCESS CXCI.

Copper diſſolved in aqua regia.

'THROW the filings of copper into *aqua regia*, or ſpirit of ſalt, and 'proceed as in the laſt proceſs, and the effect will be the ſame.

The uſe.

Aqua fortis and *aqua regia*, therefore, equally diſſolve copper. Hence all thoſe opinions, of the difference of theſe two, are inſignificant in aſſigning the reaſon why one of them diſſolves gold, and the other ſilver. The particular relative natures of things can only be learnt by experiments; it is therefore unſafe arguing that metals are ſimilar, becauſe they are diſſolved by one and the ſame menſtruum. Genuine chemiſtry draws no ſuch concluſions, but avoids generals, unleſs collected from pure obſervation.

PROCESS CXCII.

Copper diſſolved in volatile alcali.

'PUT a drachm of copper-filings into a clean glaſs, pour thereto twelve 'times their weight of the beſt alcaline ſpirit of ſal-ammoniac; ſtop the 'glaſs and ſhake it often; a blue and at length a beautiful violet tincture will 'be obtained. Pour this off, and add freſh ſpirit, and thus, by degrees, nearly the whole ſubſtance of the copper will be diſſolved, and turned into 'tincture. If copper-filings be moiſtened with thrice their weight of the oil 'of tartar *per deliquium*, and then digeſted, and reſolved; and this be ſeveral 'times repeated, and the mixture afterwards boiled, filtered, and inſpiſſated, 'a like ſolution, but of a fixed nature, will be obtained.

The uſe.

This beautiful alcaline volatile tincture holds the body of the copper diſſolved. If drank in a morning faſting, with a glaſs of mead, beginning with three drops, and daily doubling the doſe to the fourth time, when twenty-four are to be taken, walking gently after it, and then continuing the ſame doſe of twenty-four drops, for ſome days, it proves opening, warming, attenuating, diuretic; it is a powerful and ready remedy, by means whereof alone, I have cured an hydropical patient, labouring under a confirmed *aſcites*, by procuring ſuch a diſcharge of urine, that it run out as if it had been from an open pipe; ſo that the integuments of the emptied *abdomen* might be wrapt into folds: and this perſon perfectly recovering, with the uſe of a proper reſtorative, dry diet, long remained healthy. Encouraged by this

this succefs I, with a juvenile confidence of having found a cure for the dropsy, tried the fame medicine on others, but found it failed me; and thus I was taught that the affiftance of nature is required in fuch fuccefsful cures. Dropfies are of many kinds, fome curable various ways, others incurable. The fame tincture, however, deferves to be commended in all diforders from an acid, watery, weak, cold, phlegmy caufe. From our proceffes upon copper, it appears to be eafily diffolved in any acid, alcali, or neutral falt, whether manifeft or concealed; for if copper-filings be digefted in expreffed oil of olives, the diftilled oil of turpentine, or the like, which always conceal a covert acid, the copper thus turns them of a green colour, and gives them the fame virtues for chirurgical ufes: and thus much for copper.

PROCESS CXCIII.

The purification of quickfilver.

'1. TAKE mercury bought of the company at *Amfterdam*, put it into 'a piece of leather, cut round, and formed into a little bag; tie 'this bag clofe at top with a ftrong pack-thread, and fqueeze it ftrongly 'over a large glazed difh; the mercury will be thus ftrained pure, thro' 'the pores of the leather. Laftly, fqueeze the bag tight, that the whole 'may come thro': I have not found this mercury to leave any foulnefs 'behind.

'2. I have diftilled two pounds of this mercury in a clean glafs-retort, 'with a fand-heat, into a glafs-veffel, fitted to the receiver, and open at 'both ends, fo as to have its lower plunged under water; the whole body 'of the mercury thus comes over without leaving any fæces, even tho' the 'diftillation were thrice repeated in the fame retort. For ftill I had two 'pounds of mercury, a very fmall quantity of a thin fine red powder, of 'fcarce any weight, remaining in the retort, but no feculency; fo that the 'mercury, even by this tryal, was pure; which is a principal recommenda-'tion of this commodity.

'3. Take a pound of the fame mercury, put it into a retort, and add to 'it two pounds of clean lime flacked in the air; diftil in a retort with a fand 'heat, and a pound of mercury will be obtained again; fo that even thus 'no feculence is found, which, if there were any, would certainly appear 'in this method.

The ufe.

Thefe are the common ways of purifying mercury, and fitting it for the following operations; and this is the method I always ufe: and hence we fee the volatility of mercury, the degree thereof, and the purity of the company's mercury at *Amfterdam*: but for the alchemical purification, we may perhaps fpeak of it elfewhere.

PROCESS CXCIV.

Quickſilver diſſolved in aqua fortis.

'TAKE four ounces of pure mercury, and ſix ounces of aqua fortis, ' put them into a clean urinal, ſurrounded with a ſmall fire, that the ' whole may grow warm; the maſs of quickſilver will begin to bubble at ' the bottom, and conſume, whilſt red fumes and a heat are produced. When ' the mercury is diſſolved, add a little more, ſo that ſome part may remain ' undiſſolved, even in the heat; pour off the liquor, when cold, into another ' glaſs; the quickſilver will be diſſolved into a pellucid, uniform liquor, even ' tho' examined by the microſcope. It is of an auſtere taſte, ſmells like ſpi- ' rit of nitre, or *aqua fortis*, and is as colourleſs as water.

The uſe.

Hence we ſee that the very opake body of quickſilver becomes pellucid by *aqua fortis*, or ſpirit of nitre; and tho' ſo many times heavier than the menſtruum, hangs ſuſpended in a liquor fourteen times lighter than itſelf; ſtill remaining quickſilver and unchanged, only ſurrounded with the acid, as will appear hereafter. It is here ſo equably diſtributed in the fluid, that if a ſingle drop thereof be artificially examined, it will appear to contain a proportionable part of mercury, in reſpect of the whole liquor, from whence it was taken; which is a particular that deſerves the conſideration of chemiſts, and thoſe who underſtand hydroſtatics. Whence we ſee that the mercury is here very finely divided, that the acid is uniformly united with each particle of the mercury, and that this acid, equably united with the mercury, is intimately diſtributed therewith, amongſt its watery part. This ſolution is violently cauſtic, ſo that it can ſcarce be touched; as burning all the parts of the body with violent pain and heat: whence it becomes effectual in extirpating warts. If a ſmall part of a drop touches the ſkin, it preſently turns it purple. Neither *aqua regia*, nor ſpirit of ſalt eaſily diſſolve mercury; yet corroſive mercury ſublimate is a true ſalt of mercury, diſſolved by the ſpirit of ſea-ſalt, or *aqua regia*; for it produces all the true effects thereof; and if put to ſalt of tartar, regenerates ſea-ſalt. And if firſt precipitated, it may be diſſolved in *aqua regia*; but it can, alone, be ſublimed into a mercurial ſalt along with ſea-ſalt.

PROCESS CXCV.

The vitriol of quickſilver.

' 1. IF ſo rich a ſolution be made of quickſilver in *aqua fortis*, or ſpirit ' of nitre, as that no more will diſſolve therein by heat, and the ſo- ' lution be poured into a cold glaſs, there ſpontaneouſly ſhoots to the bot- ' tom a ſaline, white, tranſparent matter, from whence the liquor being poured, ' this matter remains ſharp, moiſt, ſaline, ſoluble in water, and not ſafe to be

'touched. 2. If the remaining liquor be inſpiſſated to a half, and ſet in a 'cold place, cryſtals like the former will ſhoot. 3. But if one part of 'quickſilver, along with two of pure decrepitated ſea-ſalt, reduced to 'powder, be diſtilled in a glaſs-body, with a ſtrong fire, for five or ſix 'hours, and when cold, the glaſs be broke there will be found a ſolid, dry 'mercury, ſublimed in the form of vitriol; and the common mercury-'ſublimate is a true mercury of vitriol, tho' ſemi-volatile.'

The uſe.

Quickſilver, therefore, is reduced to an imperfect vitriol, with ſpirit of nitre, and to one that is perfect with ſpirit of ſalt; but with ſpirit of nitre, it is fixed; and with ſpirit of ſalt, volatile: which makes a conſiderable difference. The vitriol is ſharpeſt, that is made with ſpirit of ſalt.

PROCESS CXCVI.

The white precipitate of mercury.

'TAKE a ſolution of mercury, made ſo ſtrong that *aqua fortis*, or the 'ſpirit of nitre can diſſolve no more; whence there remains no more 'acid than what is requiſite to diſſolve that proportion of mercury; add 'twice the quantity of pure water: then have at hand a ſtrong and hot 'ſolution of ſea-ſalt; let this fall, by a drop at a time, into the ſolution of 'mercury; upon which the liquor will immediately become white, opake, 'and turbid, where the ſolution of ſea-ſalt fell; after ſhaking the veſſel, a 'white precipitate will fall to the bottom, and a limpid liquor float above. 'After the ſolution of the ſea-ſalt no longer makes the liquor turbid, let 'the veſſel reſt for ſome time, till all the white powder is fallen; then 'gently pour off the limpid liquor, till all this white powder is ſeparated. 'Shake the remainder along with the white powder, and put it into a paper 'filter, ſet in a glaſs funnel; a limpid liquor will come away, which may 'be added to the former: and a white powder will remain on the paper. 'To this pour ſeveral hot waters, till what comes thro' be at length as in-'ſipid as it was poured on. After which the white powder will remain 'almoſt taſteleſs in the filter: dry the paper with its powder by a gentle fire; 'and afterwards keep it ſeparate, under the title of the *white precipitate of* '*mercury*.'

The uſe.

The acid ſpirit of nitre, here attracted into the mercury, and now diſſolved in the water, becomes an *aqua regia*, as ſoon as it is mixed with the ſea-ſalt; but *aqua regia* does not diſſolve mercury, like ſpirit of nitre; therefore the mercury is let go by the former ſolvent, and falls into a precipitate to the bottom. The water waſhes the *aqua regia* from the powder that externally adhered to it; yet in this powder ſome of the acid ſtill adheres to the body of the mercury, whence it has a particular virtue, as may be ſhewn by many experiments. The powder, thus prepared, is perhaps the beſt remedy hitherto

hitherto afforded by mercury, for internal ufe. It operates effectually, and with confiderable fafety. If ground with thrice its weight of loaf-fugar, it makes what may more properly be called a mercurial *Panacea*, than perhaps other laborious preparations of mercury; for, however mercury may be treated, its medicinal virtue principally depends upon a certain quantity of acid adhering to its metallic part. This acid virtue, if it abound and appear externally in the mercury, acts with more violence, but with lefs fafety: if more fparingly added, and more united to the mercury, it acts more flow, more mild, and fafe; and this is the cafe with our prefent precipitate. If the faccharine powder, above mentioned, be given in the quantity of nine grains to a perfon fafting, it purges, vomits gently, kills worms, opens and cleanfes the veffels concerned in preparing the chyle, refolves phlegm, and thus cures many diftempers, fuch as the gonorrhœa, itch, venereal ulcers, *&c.* If this dofe be feveral times repeated daily, it raifes a kindly falivation. If a drachm of this white precipitate be well mixed with an ounce of pomatum, or the ointment of rofes, it makes an excellent and fafe unguent in cutaneous diforders, and proper for curing the itch, breakings out in the face, and inveterate ulcers. It is therefore no wonder if it fhould be fubftituted in the room of the boafted *panaceas*. If this powder be put into a glafs, fet over the fire, and kept conftantly ftirring with a glafs rod, and thus be long and gently calcined, it becomes fo mild, as fcarce to purge, vomit, or falivate, and therefore acts very gently when taken internally; and in this form the chemifts commend it as a diaphoretic, and corrective: but thus treated, it is fo mild as to have little curative virtue. If a little of this powder be rubbed upon a warm and polifhed copper-plate, it prefently gives it the appearance of filver; but this foon goes off again in the fire.

PROCESS CXCVII.

Red precipitate of mercury.

'1. TAKE a pound and a half of the liquid folution of mercury, made 'according to the hundred ninety-fourth procefs, put it into a glafs 'retort, that will hold twice the quantity, apply a receiver, and diftil in 'our little wooden furnace, with fo fmall a fire as not to make the matter 'boil, yet bring it almoft to drynefs; there will remain a folid, white pon-'derous mafs at the bottom, which is extremely corrofive and fiery, fo that 'it cannot be handled. There fticks up and down to the fides of the 'glafs, fomewhat of a red, yellow, or white matter; the mercury then 'beginning to dry, in a manner that is pleafant to behold. The liquor 'driven over is a weak and confiderably pure fpirit of nitre, fit for the 'cleanfing of glaffes, and other ufes. This operation, therefore, is a kind of 'coagulating of mercury into vitriol. 2. Put the retort into a fand-furnace, 'and lute on a large receiver; diftil with a gentle fire, fo that the drops 'may follow each other, at the diftance of four or five feconds. Continue 'thus till red fumes begin to rife; then immediately apply another large 'and clean receiver; the liquor that comes over is a ftronger and purer

'spirit of nitre, to be kept for its particular uses. Urge the remainder with 'degrees of fire, and fumes will continue, and at length very red ones 'will fill the receiver; then keep up the fire, to the utmost, for two or 'three hours: there will be found in the receiver a yellow and exceeding 'strong spirit of nitre, that will afford yellow fumes for years, if directly 'confined in a clean glass: and by this means, an exceeding strong spirit 'of nitre may be procured, as being in some measure rectified; tho' it 'thus in some respect changes its nature, as it will not so well take flame 'with distilled oils. All being now cool, there will remain at the bottom 'of the retort a solid mass, of a shining red colour, between which and 'the neck, as also in the neck itself, will be found a matter of very various 'and beautiful colours; as white, yellowish, yellow, greenish, reddish, and 'highly red. Break the retort carefully, take out the red matter in the belly 'of the glass, and separate it cautiously from that which appears less red on 'the surface; for this latter is very corrosive: keep the red part by itself 'under the title of the red precipitate of mercury. 3. The chemists admir- 'ing this shining mercury, and the remarkable fixedness thereof, which was 'before volatile, imagined that, by repeating the operation, they might con- 'vert it into a fixed gold. They therefore poured fresh spirit of nitre to it, 'drew it off again, and, by often repeating the operation, thought to obtain 'gold, which *Sylvius*, in his posthumous works, asserts to have been thus 'done: but this is incredible to the cooler chemists. *Paracelsus* in the pre- 'paration of his precipitate, directs the spirit of nitre to be often drawn off 'from the mercury.'

The use.

Hence we learn the changeable nature of mercury, from fluid to solid, from volatile to fixed, from mild to corrosive, and from white into almost all kinds of colours. But however it is prepared with the acid of nitre, yet it may be recovered, in its native form and original weight, unchanged, if it be distilled by the retort, along with fixed alcali, quicklime, or iron filings. This precipitate, which goes by the name of *Vigo*'s precipitate, is sharp and corrosive, occasioning pain, and producing an escar, when externally applied; and hence, afterwards, it always occasions a thick white pus, and thus cleanses the lips and bottoms of putrid ulcers, and disposes them to heal. It is dangerous to give internally, as inflaming the *viscera* by its caustic virtue, and occasioning anxiety, pain, vomiting, purging, griping, and operating also by urine and sweat. If given in too large a dose, which should never exceed three grains; or if too often repeated, it occasions a salivation, with all its symptoms; and thus cures many distempers, that are not easily curable any other way. It is more violent and dangerous than the white precipitate. *Paracelsus* and *Helmont* shew how to mitigate it, by several times distilling alcohol upon it; and thus indeed it becomes milder, by losing much of its acid: but at the same time it requires to be given in a larger dose. They also corrected it with the same success, by distilling from it the water of the white of eggs. Others dissolve it in strong distilled vinegar by boiling, then strain and purify, and by several times distilling the vine-

gar

gar off, render the powder more mild: but there feems to be little gained by all this; white precipitate being already the thing here required. In fhort, the acrimonious acid adhering to the mercury, caufes it to operate in a very fmall dofe; and the more this acid is in it, and the more external to the mercury, the more violently it acts, and *vice verfâ.* If this precipitate be put into a thin hollow glafs difh fet over the fire, and continually ftirred with a tobacco-pipe, it will change of a deeper colour; and if long continued thus, it becomes fo much the milder, fo as at length fcarce to act at all

PROCESS CXCVIII.

Mercury-fublimate.

'DISSOLVE half a pound of mercury in a fufficient quantity of *aqua* '*fortis*, according to the hundred ninety-fourth procefs; carefully in- 'fpiffate it to a white dry mafs, according to the firft direction under the 'hundred ninety-fifth; take alfo ten ounces of decrepitated falt, and as much 'common vitriol calcined to whitenefs. Grind thefe two falts for a long 'time feparate, in a glafs mortar, with a glafs peftle, in a dry and warm 'place; then mix them together, and carefully mix in the mercury among 'them. Put the powder into a bolt-head, of which it may fill only a third 'part; cut off the neck of the glafs, fo as to leave only about feven inches 'thereof above the body: fet it in a fand-furnace, fo as that the bottom of 'it may touch the iron pot; and let the fand rife exactly up to the furface 'of the contained matter. Apply a very gentle fire, and increafe it by 'very fmall degrees, till a vapour exhales out of the mouth; which vapour 'is to be avoided, as highly pernicious to the lungs. When all the moif- 'ture is perfectly evaporated, ftop the mouth of the glafs with paper, and 'increafe the fire, till the pot be red: a corrofive mercury-fublimate will 'rife to the fides of the glafs in white tranfparent cryftals; let the glafs cool, 'then break it, and feparate the fublimate carefully from the fæces, and 'foft powder at top, and keep it in a dry glafs. For the method ufed at '*Venice*, confult *Tachenius* in his *Hippocrates chemicus.*

The ufe.

The white mercury, here employed, contains *aqua fortis* mixed in among it: the white calx of vitriol, mixed with fea-falt, enters this falt, and drives out the fpirit; and whilft thefe two act upon the mercury, by the means of fire, there is made an *aqua regia* by the fpirit of nitre, contained in the mercury, and the fpirit of fea-falt, fet free by the acid of vitriol. The phlegm is firft difcharged by a gentle fire; the ftrong acid part of the *aqua regia* unites with the mercury, and corrodes it; but this *aqua regia* is of the nature of fea-falt. The fpirit of fea falt fixes the quickfilver, not like the fpirit of nitre, but rather makes it femi-volatile; and hence the mercury is fublimed, and is a true folid dry vitriol of quickfilver, that remains confiftent in the air. The bafis of this vitriol is pure quickfilver, and the other part the

the ſtrongeſt ſpirit of ſea-ſalt, that can any way be obtained; ſo as here to appear in a ſolid form. With reſpect to this acid ſpirit of ſea-ſalt, the preparation is a *lapis infernalis* of mercury, and a moſt violent corroſive, preſently converting all the parts of the body it touches, into an eſcar, that ſoon falls off; whence it conſumes obſtinate calloſities in ulcers, as alſo warts, and indurated glands. That eminent chirurgeon *Johannes a Vigo* was acquainted herewith, and hence compoſed his troches of minium, which are an incomparable remedy for conſuming ſcrophulous tumours, and eradicating them by ſuppuration. The taſte of this vitriol is abominably auſtere. A grain of it diſſolved in an ounce of water, affords an excellent coſmetic, if cautiouſly uſed. It proves poiſonous to all cutaneous inſects by bare lotion. If a drachm of this ſolution be ſoftened with ſyrup of violets, and drunk twice or thrice a day, it performs wonders in many reputed incurable diſeaſes: but it requires to be cautiouſly uſed, by a prudent phyſician, and ſhould not be ventured upon, unleſs the method of managing it is known. This mercury, when mixed with metals, and ſemi-metals, has very excellent and inimitable effects, even ſuch as would ſurprize a chemiſt. It wonderfully changes ſilver itſelf (*a*). Certainly this mercury-ſublimate is a key, that ſerves to open numberleſs chemical ſecrets. By means of it, perhaps, ſome proportion of ſilver may be converted into gold, that could not before be found therein (*b*). Hence alſo is obtained the *menſtruum peracutum* of Mr. *Boyle*, and other things. No chemiſt will repent of the labour he employs upon this ſublimate. We ſee that *aqua regia* will diſſolve mercury better than any *aqua fortis*, provided it be firſt diſſolved in the latter; and the ſpirit of ſalt will ſublime it, tho' before fixed with ſpirit of nitre. If, according to the direction of Mr. *Boyle*, this mercury be ſublimed with an equal weight of ſal-ammoniac, it will afford a wonderful ſalt.

PROCESS CXCIX.

Turbith of mercury.

' 1. PUT four ounces of pure quickſilver into an urinal-glaſs, pour ' thereon eight ounces of rectified oil of vitriol, heat them gently ' and ſlowly; then put the glaſs upon burning coals, that the matter may ' boil gently, with care to avoid the fumes; to which purpoſe the operation ' ſhould be performed under a chimney, that the vapour may go off with- ' out coming at the lungs. The quickſilver, running at the bottom of the ' oil of vitriol, will thus begin to diſſolve. Continue the ſame degree of ' heat, till all the mercury is diſſolved; the maſs will be white like ſnow; ' calcine it, with the ſame degree of heat, to dryneſs, or till it fumes no ' longer; it will be an exceeding white and ſnowy powder, but intolerably ' ſharp, ſo as not to be touched: it is called the white calx of mercury, ' made with oil of vitriol. The operation ſucceeds in this manner, but ſcarce ' in thoſe commonly directed. 2. Grind the dry and hot maſs in a dry

(*a*) See Abr. *Boyle*, vol. I. p. 253.

(*b*) See above Proceſs 186.

' mortar,

'mortar, to fine powder; have at hand a glafs veffel full of clean hot water, 'at leaft twenty times the weight of the mercury; throw the calx into it; 'at that very inftant the white powder falls thro' the water to the bottom, 'and acquires a grateful lemmon colour. Shake the veffel for fome time, 'that the powder may be well mixed with the water; then let all fettle; 'decant the liquor into another glafs, wafh the remaining yellow powder 'with feveral hot waters, till it becomes perfectly infipid, then dry it tho-'roughly with a gentle fire: this beautiful yellow powder is called turbith 'mineral. 3. Let the firft liquor poured off, ftand for fome time, then 'ftrain, and infpiffate it to a third part; it will be a *mercurial water:* for 'if a little oil of tartar be dropped therein, a reddifh precipitate will fall to 'the bottom: and the liquor may be kept under that title.'

The ufe.

Thus the ftrongeft oil of vitriol, united to mercury, makes a white fixed powder, that will endure a very ftrong fire; as being much more fixed than one would imagine. We fee there are different effects of different acids, with regard to the colour. The white colour here is not changed with the moft violent fire, tho' it was eafily with the fpirit of nitre. This white powder, however, being calcined, becomes exceeding corrofive, and thence poifonous. Here we fee a new colour immediately arife, in a particular manner, upon the bare contact of water; for if this white powder be properly prepared, and laid in the open air, it foon grows yellow on its furface, by attracting the moifture of the air. This feems to be the powder, with which, when rightly prepared, *Paracelfus* performed wonders; as appears from his little Hofpital Chirurgeon: and this is fufficiently attefted by *Oporinus*, who declares he has frequently been employed in making it. It may be rendered milder by burning fpirit of wine upon it, after the manner of the ancient chemifts, who by this means took away from their metalline calces the falts that externally adhering thereto rendered them too fharp, fo that only the falts intimately united, might remain behind. The prudent *Sydenham*, who is a cautious and fparing commender of the chemifts, gratefully acknowledges that by means of this medicine, difeafes, otherwife incurable, might be cured (*a*). Mr. *Boyle* relates, that by a fmall dofe hereof, ufed as a fternutatory, the whole body has been changed, and even cataracts cured. A woman at *Paris* is alfo faid to have herewith cured perfons given over. Hence it feems an extraordinary medicine in ftubborn and obftinate cafes; but it requires a fkilful phyfician, and fhould not be ufed when fafer remedies may fuffice. It is ferviceable in the dropfy, as well as in the venereal difeafe, and alfo in the moft obftinate difeafes of the glands. *Helmont* fays, that oil of vitriol is here converted into alum, barely by the contact of mercury; but this is either fpeaking improperly, or not juftly: but when that excellent author directs the fire of the vitriol of copper to be poured upon *Vigo*'s powder, and thence diftilled, for preparing the fecret cathartic of *Paracelfus*, if I underftand him right, it makes this me-

(*a*) See his piece upon the *Venereal Difeafe*.

dicine;

dicine : for if the *fire of the vitriol of copper* be the ſtrongeſt oil of vitriol ; as ſoon as this is poured upon red precipitate, it immediately renders the ſpirit of nitre volatile, cauſes it to fly off from the fixed mercury, and ſoon after, ſupplying its place, produces the calx of mercury as above. If the water of white of eggs be ſeveral times diſtilled from it, this takes away the acid externally adhering thereto, and renders the powder milder, tho' it will ſtill operate ſufficiently ; which is an effect ſeldom procurable any other way. But if by fire, any thing elſe be here underſtood of a more ſubtile nature, I can fix no other meaning to it ; but by comparing *Helmont* with *Paracelſus*, I ſuſpect it is no more than what I have ſaid. Metals alone have little effect upon the body, except by their bulk, figure, and weight ; but by addition of ſalts, eſpecially the acid kind, they acquire new properties, often ſtrange ones, and very different, according as the acids are more fixed therein, or adhere more externally. In the form of vitriol they act very violently ; but if calcined in this form, the calx grows gradually milder, and by a long continued ſtrong calcination, which drives out the acids, they become mild, tho' before exceeding ſharp, as we ſee happens in turbith : and thus their operation becomes milder, and at the ſame time proportionably leſs effectual. Thoſe chemiſts and phyſicians, therefore, are miſtaken, who having found that this turbith performed extraordinary things, but operated violently, endeavoured to mitigate its virulence ; which indeed may be eaſily done, but not ſo as to have the ſame effects, when mitigated as before. The ways of mitigating the acrimony, are by taking away the acid, by waſhing the preparation with water, by frequently diſtilling pure water upon it to dryneſs, by pouring alcohol upon it, by diſtilling ſeveral parcels of alcohol upon it to dryneſs, by grinding it along with more metallic matter, as in the preparation of *mercurius dulcis*, by the addition of alcaline ſalts, which abſorb the acids, by grinding the matter with chalk, crab-eyes, teſtaceous powders, or the like abſorbers of acids, by a long continued calcination, and laſtly, by fixation with a fire gradually increaſed, from a moderate heat to the higheſt that glaſs will bear.

PROCESS CC.

The fiery oil of mercury.

'TAKE mercury calcined with oil of vitriol to a dry ſnowy calx, as ' in the preceding proceſs, ſuffer it to cool, put it into an urinal-glaſs, ' and pour thereon an equal quantity of oil of vitriol, boil as before almoſt ' to dryneſs, with great care to avoid the fumes : it now dries much more ' difficultly, and requires a longer time, and a much ſtronger fire. When ' the powder is dry, put the ſame quantity of oil of vitriol thereto, and pro- ' ceed as before ; at length it will ſcarce dry by a long continued and ſtrong ' fire, but begin to ceaſe flowing, and to grow rigid like fixed oil ; being ' highly ſharp, cauſtic, and not to be touched, like the *ignis gehennæ* of ' *Paracelſus*. By this means the mercury is ſo fixed with the oil of vitriol, ' as not to go off with the violent action of the fire.

The

The use.

This experiment ſerves to ſhew the method of impregnating, ſaturating, and incerating metals by acids, to any degree; and alſo of fixing volatile mercury by them, ſo far as is poſſible: but no metal is hence to be expected; for in whatever manner mercury is fixed with acids, yet it is again recoverable in its priſtine ſtate, by grinding it with twice its weight of iron-filings, and diſtilling it in a glaſs retort, with the higheſt degree of a ſand-heat.

PROCESS CCI.

The æthiops of mercury.

'TAKE a drachm of flowers of ſulphur, and three drachms of mer- 'cury, grind them together for a conſiderable time in a glaſs mor- 'tar; the mercury will begin to diſappear, and the ſulphur become of a 'grey colour. Continue rubbing till the quickſilver entirely diſappears, 'when the powder will grow black; and the colour will be the deeper, the 'longer the grinding is continued: and thus may æthiops be prepared in 'any quantity. This powder, by ſtanding, concretes into a ſolid black 'maſs, that may again by grinding be eaſily reduced to powder.

The use.

Hence we ſee how eaſily mercury is united to crude and cold ſulphur, barely by mechanical triture; yet ſo as to become cloſely united therewith, and not eaſily ſeparable again. The powder is ſcentleſs and inſipid, not at all ſharp, nor eaſy to be thoroughly mixed with any thing. When given internally, it cannot enter the abſorbent veſſels, the lacteals, or lymphatics, but paſſes directly thro' the inteſtinal tube; where it may happen to deſtroy worms, if it operates luckily. They are deceived who expect any other effects from it; at leaſt, I myſelf could never find them. I am afraid it is unwarily given in ſuch large quantities to children, and perſons of tender conſtitutions; as being a foſſil maſs foreign to the body, and unconquerable by the nature thereof; and ſhould be the more ſuſpected, as it there continues long ſluggiſh and unactive. It does not raiſe a ſalivation, becauſe it cannot come into the blood. Who knows the effects of a ſubſtance, which ſo long as it remains compounded, ſeems not more active than any ponderous inſipid earth? But we certainly learn from this experiment, that the acid of the ſulphur is not here attracted from the oily part, into the mercury, becauſe there hence ariſes no acrimony, but the whole remains an uniform, inſipid, ſluggiſh maſs.

PROCESS CCII.

Factitious cinnabar.

' 1. TAKE a tall earthen veſſel, that widens upwards, put into it four ' ounces of flowers of ſulphur, then melt the ſulphur over a gentle ' fire; the make and height of the veſſel thus preventing it from taking flame. ' Then take quickſilver heated, but ſo as not to fume, and pour a little ' thereof into the melted ſulphur, which will thus preſently grow viſcous; ' ſtir it continually with a thick tobacco-pipe, and continue pouring and ſtir-' ring, till thrice the quantity of quickſilver, in proportion to the ſulphur, ' be thoroughly mixed in therewith. At this time, there commonly ariſes ' a great hiſſing, with thick red fumes, and the matter takes flame with a ' noiſe; put a tile upon the mouth of the veſſel, let all cool, and the maſs ' will be found black. 2. Put this maſs, which is like the æthiops of the ' preceding proceſs, into an *Heſſian* body; cloſely lute on a head with a ' mixture of clay and lime, or elſe invert another body on the former: ſet ' it in a ſand furnace, ſo as to touch the bottom of the iron pot; bury the ' veſſel in ſand, a little below the matter; raiſe the fire gradually to the ut-' moſt; at firſt a little inſipid water will riſe, then a few whitiſh flowers, ' and at length a black matter. When the fire has been continued at the ' greateſt height for three hours, let all cool; a compact matter will be ' found ſticking to the ſides of the body, and appearing black on its outward ' ſurface: bruſh off this blackneſs with a hair's foot, grind the maſs, and it ' will appear of a fine red colour; it is called factitious cinnabar: a little ' feculent matter will remain at the bottom of the body.'

The uſe.

Thus in the firſt place æthiops is here made by fire, as it was in the preceding proceſs by trituration. Cinnabar is a mixture of mercury and ſulphur united by the fire, in the form of a ſimple foſſil; which is found natural in many mines, and is like the factitious, without much difference. It has nearly the ſame virtue, in the body, as æthiops. *Crato* called it the magnet of the epilepſy; but I never ſaw it produce any great effects. If it be mixed with purgatives, then, like æthiops, it is driven quicker thro' the inteſtines, with the ſucceſs above-mentioned of æthiops. It is mixed with red coſmetics in the form of pomatum; it is uſed in fumigations againſt venereal ulcers in the noſe, mouth, and throat, with little, and often with bad ſucceſs. The mercury may be revived very pure from the cinnabar, by grinding it with twice its weight of iron-filings, and diſtilling it in a retort, with the ſtrongeſt heat of a ſand-furnace, into water.

PROCESS

PROCESS CCIII.

Mercury amalgamated with lead, and other metals.

'1. MELT clean lead in an iron ladle; add to it an equal weight of
' heated mercury; ſtir them together with an iron rod, then let
' them cool; it thus makes an uniform maſs of a ſilver colour, ſomewhat
' hard, but growing ſofter and ſofter by trituration. Put this maſs into a
' glaſs mortar, grind it, and mix therewith any quantity of mercury at
' pleaſure, which will unite with it as ſalt with water. 2. The amalgam
' of tin is made exactly in the ſame manner; and this alſo may be diluted
' by the addition of more mercury. 3. Take a ſolution of pure copper
' made in *aqua fortis*, and ſo ſtrong, that the *aqua fortis* could diſſolve
' no more of the metal; dilute the ſolution with twelve times its quantity
' of fair water, heat the liquor, and put into it poliſhed plates of iron; the
' copper will be precipitated in the form of a powder to the bottom, and
' the iron be diſſolved. Continue thus till all the copper is fallen; pour off
' the liquor, and waſh the powder with hot water, till it becomes perfectly
' inſipid. Then thoroughly dry the powder, and grind it, in a glaſs mor-
' tar, with an equal weight of hot quickſilver. Thus an amalgam will be
' made of the copper; and may alſo be diluted by the addition of more
' quickſilver. Whoever tries to make the amalgam of copper any other
' way, will find it difficult. 4. We above obſerved in the proceſſes upon
' ſilver, that an amalgam of that metal might be made in the ſame man-
' ner, after it is precipitated pure from *aqua fortis*. 5. Diſſolve pure gold
' in *aqua regia*, till the menſtruum will take up no more, and dilute the
' ſolution with twelve times its quantity of fair water; put poliſhed plates
' of copper therein, and a gold-powder will precipitate to the bottom, and
' to the copper; keep the liquor warm till it no longer appears turbid upon
' the addition of more copper. Shake the plates, that all the gold may fall
' to the bottom; pour off the liquor, waſh the powder of gold, dry it, grind
' it in a glaſs mortar with quickſilver, and thus it will become an amalgam,
' which may afterwards be diluted with more mercury. 6. Or take a maſs
' of gold and ſilver purified with lead, and by means of proof *aqua fortis*
' ſeparate the ſilver; waſh the black powder of gold remaining at the bot-
' tom, and grind it hot, and dry, with quickſilver; and it will preſently
' make an amalgam, which may be diluted at pleaſure. Every amalgam
' is white, whatever may be the metal it is made from.'

The uſe.

In the ways above deſcribed, an amalgam may be made of any metal without loſs, except iron: the other ways are attended with a great loſs of the quickſilver, and danger from its fumes. Hence we ſee that mercury is the true ſolvent of metals. Metals, made into an amalgam, may be mixed, confounded and ſecretly concealed among one another. I believe that alchemy depends upon this ſolution of metals by mercury. Hence quickſilver is ſophiſticated with

 lead;

lead; but the fraud is eafily difcovered, by exhaling a grain or two thereof. And, perhaps, hence it is, that mercury coagulates in the fume of melted lead; which has been afcribed to a fixing property in that fume, and to a wonderful fixing metallic fpirit, even by *Paracelfus* and *Helmont*. The method is to melt lead, and when it begins to grow cold, or before it fets, to make a little cavity with a ftick therein, and in that cavity to lay a little cold quickfilver, which will there foon become folid; but this feems to happen from the lead, which ftill remains hot, being received into the mercury, and thus amalgamating, and hardening therewith. For if a little of the mercury, thus fixed, be put into a crucible, and urged with a melting heat, the mercury flies off. The fraudulent alchemifts often fecretly conceal gold or filver, in mercury; then project it on lead, and thus pretend to make gold or filver: but if a little of this mercury be put into an iron ladle, and held over the fire, the mercury flying away, and leaving the metal behind, difcovers the cheat. The making of amalgams is the foundation of the art of gilding both in gold and filver.

PROCESS CCIV.

Metals wafhed with mercury.

'TAKE an amalgam, grind it in a glafs mortar, the longer the better; 'it will begin to grow black; pour fair water upon it, and grind 'it therewith; the water will become black and turbid; then directly 'pour this off, and grind the remaining amalgam with frefh water, which 'will be difcoloured in like manner. Continue to grind, and pour on 'frefh water, till at laft it comes off as pure as it was poured on; the amal-'gam will now remain as bright as filver. All amalgams, thus treated, 'afford more or lefs of this black matter, but that of gold the leaft. The 'black powder, when dried, is found neither metal nor mercury. The 'other amalgams will fcarce ever thus become perfectly clean, fo as to leave 'no blacknefs in the water.

The ufe.

Hence pure quickfilver, mixed with metals, does fo unite with them, as to difcharge fomewhat that was latent in one, or in both. If a large quantity of this powder be procured from gold and filver, the matter of both thefe metals remains the fame, without increafing or diminifhing their weight; in which cafe, therefore, the powder muft proceed from the mercury. This is a matter of deep fpeculation; of which I ceafe to fpeak more at prefent, intending to confider it at another opportunity.

PROCESS CCV.

The solution of gold.

'TAKE four parts of *aqua fortis*, and one part of pure sea-salt, mix 'them together, they will make a yellow-coloured liquor. Put into 'it, as contained in a glass-urinal, one part of pure gold in thin plates; 'set the glass over the fire to heat, that the gold may dissolve: then by 'degrees throw in two or three grains more of gold, till at length no more 'can be dissolved with heat. Pour out the solution, and it will be of a 'gold-colour. If nothing black remain at the bottom, it is a sign no silver 'was mixed with the gold; for whatever silver there had been in it would 'have fallen to the bottom, in form of a black powder. This is the solu-'tion of gold, which is made with all kinds of *aqua regia*, however diffe-'rently prepared, as we have above related and explained.

The use.

Hence we see the reason of the term of *aqua regia*. If this liquor touches the skin, it stains it of a purple colour; it is caustic, and if taken internally, highly poisonous; if precipitated with a fixed or volatile alcaline salt, all the gold falls to the bottom. If the powder be perfectly washed with water, then very carefully dryed, with a heat of eighty degrees, it will be found increased in weight, with respect to the gold employed. When this powder, thus gently heated, comes up to a certain degree, it suddenly goes off, and vanishes, with a loud report; and hence is called *aurum fulminans*. This is a surprizing phænomenon, that can scarce be accounted for *a priori*, nor by the analogy it has to any thing else: certainly they who have hitherto endeavoured to explain it, have laboured in vain. Those who have made explosions with this powder in a large glass vessel, have recovered a little fine dust of gold. They who have given it internally, as promising themselves extraordinary effects from the great price of the secret, have thus occasioned violent pains, gripings, and other disasters. The discovery, therefore, of new and extraordinary things in chemistry, may have little relation to the service of medicine.

IV.

PROCESSES *upon* *SEMI-METALS.*

I. Upon the ſaline Kind.

PROCESS CCVI.

The analyſis of vitriol into ſpirit, oil, and colcothar.

' 1. TAKE eight pounds of the common green vitriol of *Goſelar*, put ' it into two earthen long-necks, each containing four pounds; ' cover them with a tile, ſet them upon a hearth, and ſurround them with ' fire, that the whole may grow gradually hot: the vitriol will thus begin ' to fume, and upon increaſing the fire, and bringing it nearer, to melt; ' and upon making the fire ſtill ſtronger, to thicken and turn grey. Then ' ſurround the long-necks on all ſides ſo with fire, that the matter may ' grow yellow, and begin to appear red at the ſides of the veſſels. Now ' let all cool; the long-necks will be crack'd; take out the matter, and beat ' it to powder; it will be of a yellow colour. This is the calcination of ' vitriol, in order for diſtilling the ſpirit, and oil thereof. This operation ' ought to precede, otherwiſe the diſtillation would be tedious, on account ' of the time required to draw over the aqueous phlegm; or elſe the recei- ' vers would crack, on account of that phlegm ariſing hot into them; and ' the diſtilling-veſſels alſo burſt, as being forced by the melted matter. Hence ' the matter is to be calcined only ſo long as till it ceaſes to melt in the fire. ' In this firſt part of the operation the eight pounds of vitriol are reduced ' to five. 2. Put theſe five pounds of calcined vitriol, firſt bruiſed, into ' a ſtrong long-neck, as deſcribed in the diſtillation of ſpirit of nitre, and ' ſpirit of ſea-ſalt with bole. Let the long-neck be large enough to hold ' double the quantity; ſet it in the furnace, as was before directed for pro- ' curing the ſpirits of nitre, and ſea-ſalt; when properly placed in the fur- ' nace, and the wall is built up, apply an adopter to the mouth of the ' long-neck, luting it on carefully, with a mixture of clay and lime; wrap ' a wet linen rag about the other end of the adopter, and apply thereto a very ' capacious glaſs-receiver, ſo as exactly to fit, and ſo as the adopter may not ' reach above two inches into it. Let this receiver reſt horizontally upon ' a bench, ſo that the axis both of the receiver, the adopter, and the long- ' neck may lye in the ſame horizontal plain, leſt otherwiſe the neck of the ' adopter, or the receiver, ſhould be preſſed againſt: lute the ſecond junc- ' ture in the ſame manner as the firſt, and put linen rags about it, ſpread ' with the ſame luting; and thus leave the veſſels for twenty-four hours,

' that

'that the luting may grow dry. 3. Make the fire with all the cautions 'delivered under the hundred forty-firſt, and hundred forty-fourth pro- 'ceſſes; a white fume will firſt riſe, and the receiver grow warm: keep the 'fire up in this ſtate for ſix hours; oily veins will afterwards run down 'the ſides of the receiver; and in this ſtate again continue the fire for ſix 'hours; then for ſix hours longer keep it up to its utmoſt height, that the 'long-neck may be thoroughly red hot: a thick oil will thus come over. 'If the vapour ſhould paſs thro' the luting, put a linen rag, ſpread with the 'ſame, and well heated, upon the crack; and thus it will be ſtop'd. Tho' 'the fire ſhould be ever ſo long continued, the vapour would not ceaſe to 'riſe, but the produce would not defray the coſt; ſo that I judge eighteen 'hours ſufficient. Now, therefore, let all cool, till the adoptor is but juſt 'warm, and the receiver grown quite cold. 4. Have then ready at hand 'a bottle with a narrow neck, and fitted with a wide glaſs-funnel; then care- 'fully moiſten the rags, and the luting applied to the mouth of the re- 'ceiver, and take them away gently, with care to prevent the dirt from fal- 'ling in, the fume from coming out ſo as to prove offenſive, and the glaſs 'from cracking, by being moved obliquely. Take it therefore away in a 'ſtraight line, and avoid the noxious fumes. Cleanſe the mouth of the 'receiver, that no luting may drop in; then pour the liquor out of 'the funnel into the bottle, ſtop it up, and ſet by the receiver for the 'like purpoſes. I have uſually thus obtained one and twenty ounces of thick, 'black, ſtrong, and ſmoaking oil of vitriol. A red, blackiſh, light, pow- 'dery, auſtere calx remains in the long neck, to the quantity of fifty-two 'ounces; ſo that five ounces are loſt in the operation.

The uſe.

And thus the oil or ſpirit of vitriol is prepared, which has numerous uſes in chemiſtry and medicine; for it is a moſt powerful, ponderous acid, and a great preſervative, tho' itſelf a cauſtic: and hence vitriol conſiſts of this, and colcothar, and phlegm. This oil of vitriol will ſcarce boil without a fire of ſix hundred degrees. If put into a glaſs-body, and urged with a ſand-heat of five hundred degrees, it yields its wild ſuffocating ſpirit and water, then changes from black to limpid, and becomes exceeding pon- derous, and fiery; and if poured into a glaſs wet with water, it produces ſuch a heat as inſtantly to crack the glaſs: it attracts water out of the air. If four ounces of this oil be, by a ſand-heat, diſtilled in a little retort, with a long and very curved neck, ſo as that one drop may follow another at the diſtance of ſix ſeconds, and fall into fair water, contained at the bot- tom of the retort; as pure and perfect an acid ſpirit will be thus obtained as oil of ſulphur *per campanam:* but this requires a ſkilful operator. Each drop, when it falls into the water, makes a hiſſing, as if fire had fallen therein: but if a falling drop touches the glaſs, it immediately cracks it, as if it were cut with a diamond. If a ſtronger fire be uſed, the neck of the retort cracks, the labour is loſt, and a pernicious ſuffocating fume exhales, which ought to be very cautiouſly avoided. This proceſs is otherwiſe noble, and of excellent uſe, as may be learnt from a prudent exerciſe of chemiſtry

and

and medicine. *Paracelſus* deſcribes the beſt method of preparing this ſpirit to be by diſtilling recent vitriol to dryneſs, in a veſſel of *Heſſian* earth, and cohobating the liquor upon the remainder, the oftner the better; at laſt uſing the utmoſt violence of fire: and by this means he promiſes a liquor ſerviceable in many caſes. The direction is ingenious and artiſt-like, provided the veſſel be kept from burſting by too large a quantity of the dry vitriol. The caution is, to uſe a little quantity at once, in proportion to the veſſel.

PROCESS CCVII.

Ens veneris.

'1. TAKE the remaining colcothar of the preceding proceſs, put it into a large crucible, cover it with a tile, and ſet it in the hotteſt part of the ſurface, where the fire breaks up in the diſtillation of the oil of vitriol, and there let it ſtand ignited the whole time of the operation. By this calcination, it will turn very red; then boil this colcothar in water, keeping it well ſtirred, in a glaſs veſſel; ſtrain the liquor hot; it will have the taſte of vitriol; pour freſh water to the remainder, boil, and ſtrain as before, and continue thus ſo long as the water, even by boiling, acquires any taſte. At length, keep the remaining fine red powder under the title of the dulcified calx of vitriol. If the former pure liquor be inſpiſſated, it will ſtill yield a kind of yellow vitriol; whence we learn how wonderful a body vitriol is, in reſpect of its fixedneſs in the fire, even in its ſaline part. 2. Take an equal part of this dulcified calx of vitriol, and the dried flowers of ſal-ammoniac; grind them in a hot glaſs mortar with a glaſs peſtle, for a conſiderable time, till they are perfectly mixed, but with care to prevent their growing moiſt; whence they ſhould be ground on a clear dry day, and in a warm place. Put the powder into a low earthen body, fit on a wide alembic-head, with a wide pipe; apply a ſmall receiver; place the veſſel in a ſand furnace, ſo as almoſt to touch the iron pot; half bury the body in ſand, and raiſe a fire by degrees. There firſt comes over a ſharp, volatile, yellowiſh liquor, of an intolerable odour, and an exceeding ſharp, fiery taſte, almoſt as in the ſublimation of iron, in the hundred ſixty-ninth proceſs; the method being here nearly the ſame. The fire being increaſed, and the liquor drove over; firſt white, then yellow, and ſoon after very red flowers will riſe: continue the fire for ſix hours, making it ſo ſtrong at laſt, as almoſt to ignite the iron-pot. Let all cool; there will be found in the head and upper part of the body, a beautiful, red, ſaline, aſtringent ſublimate, very like the flowers of iron. Let it all be carefully taken out, and directly put into a dry glaſs. A matter will be found at the bottom, of an auſtere taſte, that eaſily ſwells, and in ſome meaſure runs in the air: but the production will be different, according as the vitriol was from copper or iron.'

The uſe.

Here we ſee the metallic part of vitriol, that remained ſo fixed in the fire, is rendered volatile by ſal-ammoniac. The nature of this iron from vitriol ſo

ſo calcined, is nearly the ſame in the flowers, as in the crude iron of the hundred ſixty ninth proceſs; and might therefore rather be called *ens martis*, than *ens veneris*. When prepared from the calx of blue vitriol, it then deſerves to be called *ens veneris*. And hence we may underſtand the death and reſurrection of metals, mentioned by *Paracelſus*. A ſmall proportion of this ſublimate turns a large one of the infuſion of galls to ink. Mr. *Boyle* promiſes great effects from this remedy, in diſtempers proceeding from a weakneſs of the ſolids, as in the rickets, or the like; and it is highly ſerviceable therein. *Helmont* alſo in the treatiſe he intitles *Butler*, greatly commends a like preparation. But as even after the utmoſt violence of the fire ſuſtained, both in a cloſe and open veſſel, there ſtill remains ſomething vitriolic; it is no wonder, that the fumes of vitriol, continually remain, how long ſoever the diſtillation be continued: doubtleſs this wonderful body deſerves to be examined.

II. Proceſſes upon the Sulphureous Semi-Metals.

PROCESS CCVIII.

Antimony diſſolved in aqua regia.

'TAKE pure antimony, broke from the top of the cone, reduce it to 'fine powder, put a pound thereof into a low capacious glaſs-veſſel, 'with a wide mouth; ſet the veſſel under a chimney, that carries up fumes 'well, and pour to it a pound and half of *aqua regia*. A violent effer-'veſcence ariſes, a great heat, thick red fumes, and a hiſſing, all which 'ſoon after ceaſe. There now remains at the bottom a matter of a grey 'and yellowiſh colour, moiſt, thick, and pappy, which is to be dried over 'a gentle fire, by keeping it ſometimes ſtirred with a ſtick.

The uſe.

This is the humid calcination of antimony, whereby the foſſil, which before was neither emetic nor purgative, now acquires very violent virtues. The yellow matter diſperſed amongſt this calx is the true ſulphur of antimony, which the acid not diſſolving, it is ſeparated from the other metallic part of the antimony, which diſſolves in *aqua regia*; whence we have both a calcination, and ſeparation in this proceſs; which is ſubſervient to the following operations.

PROCESS CCIX.

The true ſulphur of antimony.

'TAKE the calx of the preceding proceſs, waſh and ſhake it with 'water, pour off the thick into another veſſel; put on freſh, and con-'tinue thus, till the yellow lighter matter diſperſed in the water, is ſepa-

'rated from the more ponderous metallic part, which is to be kept apart: 'the fulphureous part, which falls to the bottom, being freed from the 'whitifh water floating above it, may be thrown away. Then dry the 'powder by a gentle fire, and it will be true fulphur. If fomewhat larger 'pieces of antimony were put into *aqua regia*, and the folution thus per-'formed, larger pieces of fulphur would be obtained; becaufe the *aqua* '*regia* feeks out, and diffolves the larger metallic parts concealed in the 'fulphur, and fo makes the maffes of fulphur more vifible.'

The ufe.

Hence it appears how fecretly fulphur may lye concealed between metallic fhoots; and how furprifingly *aqua regia* can find out metal thro' the body of fulphur; and again, how unchanged the nature of fulphur may remain. This is the fulphur of antimony, which *Helmont* orders to be extracted, and which he fays fcarce differs from the common, except in being a little greener: in reality, the difference is fmall; nor does, perhaps, the cinnabar made with it, deferve the trouble, in refpect of any greater virtue. Certainly, a feventh repetition of its fublimation, which he prefcribes, is not fo eafy to perform as to direct. The experiment, however, fhews, even to the eye, that antimony confifts of a metallic and fulphureous part.

PROCESS CCX.

Glafs of antimony.

'1. PUT two pounds of powdered antimony into a large unglazed 'earthen difh, with a flat bottom, fet it over a fire in the air, fo that 'the powder may fume, but not melt; in which management the whole art 'confifts. Keep the powder conftantly ftirring with an iron-rod; there flies 'off a thick, white, fetid fume, pernicious to the lungs, and therefore to 'be avoided by the operator, ftanding with his back to the wind. Conti-'nue the calcination uniformly, till the matter ceafes to fume; then increafe 'the fire a little; and if the matter again begins to fume, continue ftirring 'till it leaves off. Again increafe the fire, till at length the difh begins 'to grow red, whilft the matter emits no more fume: the calx will be of 'a greyifh colour; but if the calcination be longer continued with a ftronger 'fire, fo as to ignite the matter, the calx will be yellow, and better 'purified from its volatile parts. If the fire fhould be ftrong at the firft, 'fo as to melt the antimony, and make it lumpy, the lumps are directly to 'be broke to powder, and the fire to be diminifhed. This is the calcina-'tion of antimony *per fe*, and a thing of great ufe. 2. Put this calx into a 'crucible, and apply fire round it, firft at fome diftance; gradually approach-'ing it nearer, and at length bringing it quite clofe, fo that the crucible 'being exactly covered to prevent the coals and afhes from falling in, may 'be thus uniformly heated and ignited. Increafe the fire, till the calx melts, 'keep it fufed for half a quarter of an hour, then pour it out, upon a dry

'and

'and hot marble: it will be a duſky, yellowiſh, brittle, ſomewhat tranſpa-'rent, and hard cake, called the glaſs of antimony; it will appear the more 'tranſparent, the longer it was boiled in the fire.

The uſe.

Sulphur conſiſts of common brimſtone and a metallic matter, as we ſaw in the two hundred and ninth proceſs; but ſulphur is totally volatile in the calcining fire here applied, as appears by the hundred and fiftieth proceſs: the metallic part ſuſtains a fire of fuſion, as appears by its being melted, and poured into cones; but then it always yields a white ſuffocating fume. Hence we underſtand, that powdered antimony, being roaſted in a fire that does not melt it, this gradually drives out the external ſulphur, thence purifies the metallic glebe, and at length reduces it to a calx, which, tho' the antimony was innocent before, now proves violently emetic: whence this ſhould happen is not hitherto well underſtood. This calx, when melted, is the glaſs of antimony, made after the manner that we ſaw of lead. Antimony and lead are by the adepts ſaid to agree in many reſpects; and it appears in this, that the calces of both turn into glaſs by fuſion. The glaſs of antimony is almoſt mortally emetic; and when infuſed in wine, that is not conſiderably acid, it renders the liquor vomitive, without any great loſs of its ſubſtance; tho' this virtue is ſoon exhauſted, by often repeating the infuſion: and hence proceed the common emetic wines. This glaſs, in fuſion, conſumes almoſt all metallic bodies, upon the teſt, except gold, to which it gives a beautiful and rich colour.

PROCESS. CCXI.

The regulus of antimony with ſalts.

'1. THIS effect is obtained by any method of ſeparating the metallic 'from the ſulphureous part of the antimony; and the more exact 'the ſeparation is made, the purer the regulus will be. Foſſil antimony, 'in its native glebe, being put into conical earthen-pots, with the narrow 'end downwards, is melted with a gentle fire, ſufficient to make them red-'diſh, into large cones; whilſt the purer, more ponderous, and metallic part 'remains below, in the *apex* of the cone, and the upper wide part is more 'ſpongy, duſky, and ſulphureous: and thus a regulus is made by bare fuſion.
'2. Take two parts of common nitre, three of good tartar, and four of 'pure antimony; let them be dry, and grind them ſeparate to fine pow-'der; then rub them together perfectly dry, till they are thoroughly mixed. 'Let the maſs be made moderately hot, but chiefly very dry; then ſet a 'large crucible carefully in the fire, ſo as to be on all ſides ſurrounded 'with the coals, and perfectly ignited: throw into it two drachms of the 'mixed powder made hot, and very dry; there will ariſe a violent de-'flagration, with a conſiderable noiſe, and ſparks flying every way about. 'After the detonation is over, throw in the like quantity; and continue thus 'till all that was intended, and anſwering to the ſize of the crucible, be

'thrown in. The cautions required in the operation are these. Let the 'crucible be large, lest the matter in boiling up violently should run over: 'throw in but little powder at a time, lest it should leap out of the vessel 'in large sparks. Let each part thrown in be perfectly fired, brought to 'rest, and thoroughly ignited before another is added; lest the matter, be-'ing hotter below, and colder above, should form a crust at top, so as to 'confine the fire, and occasion a sudden loud explosion, which might be 'much more violent than that of a musket: for gunpowder is thus form-'ed of the nitre, tartar, and sulphur. Let the crucible be kept constant-'ly hot, to prevent the same explosion and danger. A person unac-'quainted with these particulars, and endeavouring to make regulus of '*antimony*, in the method directed, may endanger his life; but if these cau-'tions be carefully observed, the whole may be safely done. And after 'the matter is all detonated, increase the fire, cover the crucible with a tile, 'and make the matter flow like water; have ready at hand a metallic 'melting cone, perfectly dry, a little heated and greased on the inside with 'tallow-candle, into which at once pour all the melted matter, and imme-'diately shake the cone; there instantly arises a flame from the firing of the 'tallow. Let all rest and grow cool, invert the cone, and give a stroke 'on the basis with a hammer, thus the regulus will fall out; the lower 'part whereof is the metallic matter of the antimony, the upper consisting 'of the salts and sulphur: the upper metallic surface where it touched the '*scoria* has the figure of a star impressed upon it: the *scoria* swells, and re-'lents in the air.'

The use.

As this process lays a solid foundation for the business of metallurgy, it deserves to be carefully considered. In the first case, therefore, the fossil mass of antimony, being melted, with a proper fire, becomes fluid and ponderous: whence the lighter adhering matters, such as stones, and other bodies, not cleaving to the metallic part in fusion, are by the law of hydrostatics, thrown to the top, and separated, so as to render the metallic part more pure and ponderous. And thus, in metallurgy, the metallic matter is often separated from the rest by fusion. But in the second case, the metallic matter is by another metallurgical art separated from the sulphur, which would not separate by simple fusion, but remained intimately mixed with the former; and this was done by means of the powder of nitre and tartar, and is therefore called the flux-powder. For, as antimony consists of sulphur and metal, according to the two hundred and eighth, and two hundred and ninth processes; being here mixed with nitre and tartar, and committed to the fire, the nitre and the tartar, together with the sulphur of the antimony, immediately take fire with great violence, according to the hundred and thirtieth, and hundred and thirty-second processes; whereby a fixed alcali is made of the nitre and tartar, as in the hundred and thirtieth process. But this fixed alcali, being agitated by the violence of the fire, greedily drinks in and unites sulphur to itself, according to the hundred fifty-second process; whilst the metallic, or mercurial part remaining untouched by the alcali,

alcali, freed from its ſulphur, fuſed by the fire, and fallen downwards from the lighter matter, unites at the bottom into a regulus. And as the long pointed *ſpiculæ* of the antimony, when left ſeparate, range themſelves horizontally upon the ſurface, from the centre to the circumference, they thus form a ſtar, which the alchemical *Magi* adore. This regulus, tho' it appears pure, being again fuſed with alcali, affords a new ſulphureous *ſcoria*, and perhaps will never become perfectly free from ſulphur; whence it is always brittle: for ſulphur always deſtroys the ductility of metals. The *ſcoria* is the ſulphur of metals diſſolved in fixed alcali, as in the hundred and fifty-ſecond proceſs, whence its virtues are eaſily underſtood. This regulus of antimony is emetic, like the glaſs of the preceding proceſs; and in the ſame manner renders wine vomitive, by being infuſed therein. And hence we have another way of purifying metals by ſalts, from all their ſulphureous and arſenical matters, which renders metallic glebes fragile and volatile, and which, when ſeparated, leaves the metal pure and fixed.

PROCESS CCXII.

Regulus of antimony with iron and nitre.

'TAKE half a pound of bright iron-filings, heat them in a crucible, ' gradually put thereto a pound of finely pulverized antimony, firſt ' well dried and heated; keep it in a ſtrong fire, ſo that it may flow thin; ' by degrees throw in four ounces of pure, dry, and hot pulverized nitre; ' make the fire violent, that the maſs may run like water; keep it thus for ' half a quarter of an hour; then pour it out into a melting-cone, as in the ' preceding proceſs. There will thus be obtained ſeven ounces and a half ' of ſtellated regulus, as bright as ſilver. The *ſcoria* here is of a very dif- ' ferent nature from that of the laſt proceſs, being dry, hard, irony, ſulphu- ' reous, ſaline, ſharp, and will ſcarce relent in the air.'

The uſe.

The ſulphur of melted antimony eaſily joins itſelf with ignited iron, according to the hundred and ſeventieth proceſs; and hence proceeds a ſulphureous *ſcoria* of iron: and upon the addition of nitre there ariſes a ſtrong deflagration with ſome part of the ſame ſulphur, according to the hundred thirty-ſecond and hundred thirty-third proceſſes. And the fuſion, being here perfect, the metallic part of the antimony falls alone to the bottom, by its own gravity; whilſt the ſulphur of the antimony, along with the iron and nitre, are ſeparated and float at the top. *Paracelſus* obſerved, that iron ſeparated the ſulphur of antimony much more intimately, from its mercurial part, than vegetable alcali could; and therefore, that this operation was much fitter for ſeparating the mercurial part of antimony for ſecret chemical uſes. The experiment certainly ſhews that ſulphur may be excellently extracted from ores by means of iron, and hence their metals rendered fixed, and malleable;

able; whence *Alexander Van Suchten*, a diſciple of *Paracelſus*, wrote two treatiſes in this view upon antimony; from whence we have the following proceſs.

PROCESS CCXIII.

The alchemical regulus of antimony.

'1. PUT half a pound of iron nails into a ſtrong and large crucible; ſet 'it in a wind-furnace; raiſe the fire till the nails are perfectly ig'nited, whilſt the crucible remains covered: then add, at ſeveral times, a 'pound of dry and thoroughly heated antimony, reduced to powder; 'cover the crucible a while: as ſoon as the antimony is put in, it 'yields a white fume, and ſoon after runs, and thus alſo preſently melts 'the iron: when they flow thin, which is known by trying with a long 'tobacco-pipe, throw in, at ſeveral times, three ounces of very dry and hot 'powdered nitre. After each injection there ariſes a ſtrong ebullition, a 'tumult, noiſe, and ſometimes a crackling, or decrepitation. And if the 'nitre were thrown in moiſt, the veſſel would burſt, and the matter fly 'about in a very dangerous manner. When it has continued thus for ſome 'time, ſhining ſparks are thrown out. Let the whole flow like water for 'five or ſix minutes, then pour it out, whilſt very thin, into a melting-'cone, which being directly ſtruck on the outſide, and ſuffered to cool, 'the regulus will eaſily fall out. I have thus had eleven ounces and ſix 'drachms of it, and eleven ounces of ſcoria; ſo that the loſs was four ounces 'and two drachms, beſides what remained in the crucible upon pouring out. '2. Melt this regulus again in a new crucible, and throw into it three 'ounces of dry and hot powdered antimony. When melted, throw to 'them, at ſeveral times, three ounces of dry and hot powdered nitre; fuſe 'them with a ſtrong fire, and keep them five minutes in a thin fluid ſtate: 'then pour out the matter into a melting-cone, and it will afford ten ounces 'and ſix drachms of a pure regulus. 3. Melt this ſecond regulus in a new 'crucible, and after the ſame manner throw to it three ounces of nitre; uſe 'a very violent fire, otherwiſe it will not run; pour it into the cone, and 'thus nine ounces and two drachms of a regulus will be obtained, white 'like ſilver, and beautifully ſtarred: there remains two ounces and ſeven 'drachms of ſcoria, ſo that the loſs is an ounce and five drachms. 4. Melt 'this regulus alſo in a new crucible, and throw in three ounces of nitre; 'the nitre now requires a violent fire to make it run, tho' the regulus flows 'like water below it; keep them in liquid fuſion for an hour, then pour 'them into a melting-cone; thus there will be obtained ſeven ounces and 'three drachms of an extremely pure regulus, like ſilver, and beautifully 'ſtarred: there remain two ounces and ſeven drachms of ſcoria of a gold-'colour, and very fiery taſte. This is a ſurprizing experiment. 5. The 'crucibles here ought to be ſtrong, ſound, large, and properly heated by 'degrees: the fire muſt be ſtrong and equable, otherwiſe the nitre will not 'melt, nor the operation ſucceed; the melting-cones muſt be moderately

'hot,

'hot, perfectly dry, every way pure, and greased with tallow-candle; and 'if these cautions be observed the operation will succeed.

The use.

This process shews us many useful particulars: for example, iron, which is so hard of fusion, melts in antimony, as all other metals do in lead: the iron, corroded by the melted antimony, unites with the sulphur thereof; the mercurial part of the iron and the antimony are set free, unite together, and fall to the bottom: the sulphur of the antimony and the iron unite, and rise to the top. Nitre being thrown in, burns violently with these sulphurs; intimately agitates the minutest part of the whole, and all the principles, uniting the similar, and separating the dissimilar parts. Iron is destroyed by the force of antimony, whilst the metallic sulphur of the iron, that is the gold of the alchemists, intimately unites with the metallic sulphur of the antimony; and they both remain with the mercurial part of the antimony in the form of a stellated regulus, which shining like silver, shews the purity of its mercury. The scoria contains the iron, the sulphur of the antimony, and the nitre united together, into a wonderful body; the secret medicinal virtues whereof will be recommended by such as know how to treat and apply it properly (*a*). It strangely swells in the air: and so much of the first fusion. In the second, the external sulphur is farther drawn out; the metallic sulphurs of the iron and antimony, together with their mercuries, are more fixed into a purer regulus; the sulphureous scoria floating upon the nitre. In the third fusion, a wonderful power of the sulphureous metallic fire, concealed in this regulus, begins to shew itself, and by fixing the nitre, renders it extremely difficult to fuse; whereas it was before of all natural salts the readiest to melt in a gentle heat; and giving it a most intolerable fiery taste, so as to burn the tongue; whereas the proper taste of nitre is very cold. It turns the nitre alcaline without the assistance of any vegetable, and makes it spontaneously melt in the air, in which it remained dry before. The fourth fusion shews the same more manifestly; where the nitre is thus more powerfully changed by the bare touch, or as it were the breath of the pure sulphur; which shews the secret power of metallic sulphurs. This regulus has surprized the most experienced chemists. See *Paracelsus*, *Suchten*, *Philaletha*, *Pantaleon*, *Becher*, and *Stahl*. The colour of gold is as much exalted by means of this regulus, and restored when lost, as the whitest nitre, when thrown upon this regulus in fusion, immediately thence acquires a golden colour. When I recollect the labour and time I have bestowed upon examining the nature of this regulus, I am surprized at my own patience and resolution; and blush to have spent so large a part of my life upon it: but every man has his pleasure. The regulus, tho' thus purified, is still emetic; and the scoria gives a rich tincture to alcohol.

(*a*) The author intimates below that it gives a rich tincture to alcohol.

PROCESS

PROCESS CCXIV.

The golden ſulphur of antimony.

‘ BOIL the ſcoria of the two hundred and twelfth proceſs in water, till ‘ it is all diſſolved; the ſolution will be ſcentleſs: drop vinegar into ‘ it, and there inſtantly riſes a very fetid ſtercoraceous odour; and the liquor ‘ that before was thin becomes very thick. Continue to add more vinegar, ‘ and ſtir the matter, till nothing farther precipitates. Let the matter reſt; ‘ the precipitate will gradually fall, and come into a much ſmaller compaſs ‘ than one would expect: pour off the liquor, waſh the precipitate in ſeve- ‘ ral waters, till it becomes perfectly inſipid; dry it gently; there will be ‘ but little of it; and this is the golden ſulphur of antimony.

The uſe.

The ſulphur of antimony, mixed with alcali, makes the ſcoria of the two hundred and twelfth proceſs; which ſcoria being boiled in water, affords a ſulphureous lixivium, that with acids precipitates the ſulphur. It has a mild emetic virtue; and is called golden ſulphur, becauſe, when rubbed upon ſilver, it gives a gold colour thereto.

PROCESS CCXV.

The crocus of antimony.

‘ REDUCE equal parts of antimony and nitre to fine powder; heat an ‘ iron-ladle over the fire, almoſt red-hot; throw a little of this pow- ‘ der therein; it takes flame like gunpowder; when the flaſh is over throw ‘ in more, which takes fire as before. Continue thus till all the powder is ‘ thrown in; it will be of a brown yellowiſh colour; a kind of glaſs remain- ‘ ing at the bottom, and a lighter ſcoria at the top. Grind the whole to ‘ fine powder, and waſh it with hot water, till the browniſh-yellow calx ‘ remains inſipid; which when dried, it is the *crocus* of antimony. Filter ‘ the waters to render them tranſparent; drop a little vinegar into them; ‘ they turn of an orange colour, and let fall to the bottom a powder ex- ‘ tremely like that of the preceding proceſs, but finer.

The uſe.

Sulphur and nitre make a kind of gunpowder with black antimony, and therefore flaſh off in the ſame manner. The metallic part calcines to a glaſs and a ſcoria, both of them violently emetic, and communicating that virtue to wine by infuſion; whereas native antimony is not vomitive. Here is a remarkable change of colour. If the operation be performed in a large crucible, with a ſtrong fire, and a great quantity of matter, which is made to melt, there will be an extemporaneous glaſs found at the bottom; and which being

'being separated from the scoria, is the same for medicinal uses, as that 'more laboriously prepared in the two hundred and tenth process.'

PROCESS CCXVI.

A mild emetic from antimony.

'GRIND one part of antimony with two of nitre; throw them by a 'little at a time into an ignited crucible; they will detonate as in the 'last process; but the matter will prove white, and being washed, affords 'a white insipid calx of antimony: the water used in the washing is saline, 'when filtered.'

The use.

The proportion of nitre being here increased, gives a different colour, but the same deflagration. This calx is so mild, as often to occasion only some light *nausea* and gentle vomiting, with a large discharge of *saliva* and thick urine, from stimulating the *viscera*. Its lixivium being precipitated with vinegar, affords a white calx of nearly the same virtue.

PROCESS CCXVII.

A diaphoretic antimony with nitre.

'TAKE one part of antimony, and three of nitre reduced to fine pow-'der; throw them by a little at a time into an ignited crucible de-'tained in the fire; they will deflagrate as above. Continue thus till all the 'powder is put in; with care not to add fresh till the former is perfectly 'deflagrated. Keep the matter for a quarter of an hour in the fire, that the 'crucible may remain ignited: let all cool; there will remain a white and 'hard mass, which being taken out, and reduced to powder, is the diapho-'retic antimony with nitre.'

The use.

This matter, thus rightly prepared, being taken in the quantity of half a drachm, scarce occasions any sensible change, excepting that it moderately opens on account of the fixing nitre adhering thereto; whence it may prove serviceable in acute cases. In this state the chemists call it diaphoretic, and judge, that the arsenical poison of the antimony is fixed by a large proportion of nitre; but there was nothing emetic in the antimony before, tho' taken in the quantity of several drachms crude, or without any nitre; whereas an equal proportion of nitre excites this vomitive virtue. Let us not reason too far, but rest safe in the experiment. *Basil Valentine* therefore, and other chemists, needed not have been so anxious to free this diaphoretic antimony from its fixing nitre; for it causes no anxiety, *nausea*, or vomiting, and only stimulates mildly: but the washed calx proves more mischievous.

PROCESS CCXVIII.

Common diaphoretic antimony.

'REDUCE the calcined antimony of the preceding proceſs to fine
' powder; waſh it with hot water; mix it with a ſtick; whereby the
' adhering, fixing nitre will be diſſolved, and a white calx ſubſide by ſtand-
' ing. Pour off the ſaline liquor, add freſh water, and edulcorate the calx,
' ſo that no ſenſible taſte of the nitrous ſalt may remain; then dry the pow-
' der, and it will be white, inſipid, and ponderous, or the common *antimo-*
' *nium diaphoreticum.*'

The uſe.

This preparation is called diaphoretic, for the reaſon mentioned in the laſt proceſs. It is an indolent, noxious calx, without any activity diſcoverable by obſervation; and loſes all the virtue it had before. It only acts ſenſibly; when mixed in a double proportion with purgatives, the virtues whereof it actually excites, as appears by ſure examples in the *pulvis cornachini*; but I recommend it for no other uſe. Hence we ſee how wonderfully the colours and virtues of antimony are changed, by barely changing the proportion of the nitre in its calcination.

PROCESS CCXIX.

Nitrum antimoniatum.

'PUT the filtered waters of the preceding proceſs into a glaſs-urinal;
' evaporate to drineſs, and keep continually ſtirring; at laſt there re-
' mains a white ſaline matter, of a particular taſte, not ungrateful, nor ni-
' trous, but mild; and this is called *nitre of antimony.*'

The uſe.

Hence we ſee the nitre is changed into a new ſalt, by detonating with antimony. This ſalt is gently aperitive, and, in denſe inflammatory blood, excellently reſolves without violence: it ſucceſsfully promotes perſpiration, ſweat, and urine; hence cools and becomes ſerviceable in the ſmall-pox, meaſles, pleuriſy, and peripneumony: it is therefore wrong to throw this water away as noxious; which is commonly done.

PROCESS CCXX.

The fixed ſulphur of antimony.

'TO the filter'd nitrous liquor of the preceding proceſs, whilſt it remains
' hot, and contained in an urinal, drop ſtrong diſtilled vinegar; the
' liquor will preſently turn milky, and a very white and fine powder preci-
' pitate,

'pitate. Shake the glaſs, continue to drop in vinegar, and ſtir the liquor
'till it appears no longer turbid; then let it reſt till all the powder is fallen:
'afterwards pouring it off into another veſſel, perfectly edulcorate the pow-
'der with water, dry it, and it will be exceedingly white and fine: this
'is called the fixed ſulphur of antimony.

The uſe.

In the deflagration of antimony with nitre, the ſulphur of the antimony unites with the nitre; as appears by the two hundred and fifteenth proceſs: and the ſame is the caſe here; but the ſulphur, ſo diſſolved and joined with the nitre, alſo diſſolves with it in water, and, by the addition of an acid, is precipitated out of the nitre, as here by the means of vinegar, which joins with the nitre, without any ſign of effervefcence: the powder precipitated and waſhed is the true ſulphur of antimony. *Tachenius* commends this powder as an excellent antipeſtilential remedy, if taken with vinegar. In my opinion the powder is to be eſteemed a ſluggiſh calx, inſoluble, and hurtful by its weight; at beſt not ſerviceable: the vinegar, however, given with it, I own, is an excellent remedy in the plague: but it is uſual with Chemiſts raſhly to commend whatever their art prepares, eſpecially from antimony; and the more, if it does not operate violently. The acetous, nitrous liquor, that floats above the precipitate, has extraordinary virtues in all acute, feveriſh diſorders, as well on account of the vinegar, as of the mild nitre, now ſet free from its former ſluggiſh ſulphur: and thus the beſt things are often thrown away in chemiſtry. In theſe ſeveral proceſſes we ſee how wonderfully ſulphur may be diſſolved, lie concealed, and be raiſed again in various forms and colours.

PROCESS CCXXI.

The diſtillation of antimony into an icy butter, and cinnabar.

'GRIND two pounds of corroſive mercury-ſublimate to fine powder,
'in a warm and dry glaſs mortar, with a glaſs peſtle; grind alſo ſepa-
'rate a pound of the beſt antimony perfectly fine; mix the two together in
'the glaſs mortar; they will thus grow warm; and let the vapour be care-
'fully avoided: have at hand a dry glaſs retort, capable of holding three or
'four times this quantity of matter, with its neck cut off, ſo as to leave a
'wide mouth. Put the powder, whilſt thorough dry, into this heated and
'dry retort, ſo that no blackneſs may ſtick internally to the ſhort neck; put
'the retort into a ſand-furnace fit for the purpoſe, ſo as almoſt to touch the
'bottom of the iron pot, the neck of the retort inclining a little downwards;
'apply a glaſs receiver, with the neck cut off, ſo as exactly to receive the
'retort. Cover the retort with ſand, and let the operation be performed
'under a chimney that entirely carries up the fumes. The retort being now
'warmed by a very gentle fire, and luted on with a mixture of lime and clay,
'raiſe the fire cautiouſly, by degrees; the retort will firſt appear cloudy,
'and a little liquor come into the receiver; keep up this degree till no more

‘ liquor comes over; then increafe the fire gradually and carefully, till an ‘ unctuous matter rifes into the neck of the retort, diftils into the receiver, ‘ and coagulates in falling. Continue this degree of fire, and a white icy ‘ matter will concrete, and remain in the neck of the retort; on both fides ‘ of which place live coals at a diftance, and approach them nearer by de- ‘ grees, that the neck of the retort may become as hot as the belly; the ‘ matter will thus be melted, and run down into the receiver. Continue ‘ carefully with this degree of fire, and afterwards a little increafe it, till no ‘ more butter rifes, and all of it be melted down into the receiver, which is ‘ now to be removed with great care, to prevent any of the vapour coming ‘ to the lungs. Immediately ftop the receiver, and fet it by; apply another, ‘ fitted in the fame manner for the purpofe; lute it on, increafe the fire, ‘ and a yellow, red, blackifh, varioufly coloured mafs will arife; then increafe ‘ the fire to the utmoft, at laft raifing a fire of fuppreffion, till the fand ‘ almoft grows hot; and leave it thus for two hours. Let all cool; take off ‘ the receiver, wherein fome quantity of running mercury will be found, and ‘ an impure butter, from the fulphureous fumes of the fulphur of the ‘ antimony. In the neck of the retort will alfo appear a matter of various ‘ colours, confifting of the mercury, fulphur, and butter, compounded to- ‘ gether; and at the bottom of the retort, when broke, appear antimonial ‘ fæces: in the beginning of the neck is a compact, hard, opake, highly ‘ ponderous mafs, which fhines on the furface contiguous to the glafs, but is ‘ rough on the other: this being ground to powder is the true cinnabar of ‘ antimony, and a thing of value. Great patience and care are required in ‘ this procefs; becaufe if the veffels or luting crack, or the fumes any other ‘ way efcape, and are received into the lungs, they are poifonous, on ac- ‘ count of their cauftic property.

The ufe.

From a knowledge of the nature of antimony, and mercury-fublimate gained by the preceding proceffes, we may eafily underftand the chemical *rationale* of the prefent operation. Whilft the fire acts upon the mercury-fublimate, the *aqua regia* contained therein unites with the mercurial, metallic, reguline part of the antimony, forfaking the mercury whereto it was firft joined, and leaving it to run at the bottom, whilft the regulus is fublimed along with the falt, and becomes the volatile vitriol, or butter of the antimony, confifting of pure regulus of antimony, and fea-falt, united into a vitriol. When thefe are feparated and fublimed, there remains in the retort a fulphur of antimony deferted by the regulus, and a pure mercury deferted by the acid; whence thefe two, uniting with the heat, fublime into cinnabar. This butter of antimony is a moft immediate cauftic, caufing an efchar the quickeft of any thing known, and which generally feparates the fame day it was formed. This butter eafily melts in a moift air, then lofes its tranfparency, turns white, and precipitates a white powder. The various colours in this procefs arife from the fulphur of the antimony. The butter here produced melts with heat, and again freezes with cold. If inftead of antimony, the pure regulus of antimony, made according to the two hundred and thirteenth procefs, be ufed, and the

the operation be performed in the fame manner, a pure butter only, and a pure mercury will be obtained, becaufe there is now no fulphur; and all the acid being drank into the regulus, the mercury is recovered feparate and pure. Here we fee an extraordinary property of fpirit of falt, which adhering to the mercury-fublimate, is able with a fand-heat to fublime the fixed regulus of antimony. It likewife does the fame to all metallic bodies, even gold itfelf. Sea-falt is a wonderful body, upon which the chemift can never fufficiently operate, and will always be rewarded for the pains he fhall beftow upon it.

PROCESS CCXXII.

Butter of antimony diftilled into a liquid oil.

'BREAK butter of antimony to pieces by means of fome glafs inftrument; put it into a clean glafs retort, with care to avoid its melting by the air, left the vapour fhould offend the operator; diftil it with a gentle fire, gradually increafed, into a pure dry glafs receiver; continue increafing the fire till all the butter is come over, ufing a ftrong one at laft; it will be almoft liquid, in form of the oil of antimony; and, if diftilled thrice over, it becomes clearer, and, when well kept in a clofe veffel, remains in this ftate.'

The ufe.

This is a very extraordinary event, and may ferve to illuftrate fome obfcure paffages of *Paracelfus*. This excellent experiment difcovers many particulars concerning the volatilizing of metals, and converting them into a true kind of liquid oil; the infcrutable power of fea-falt for procuring of volatility to metals; and its wonderful property whilft remaining united with antimony, as being then highly poifonous, and yielding true arfenical fumes, yet when feparated from the antimony again becoming perfectly innocent. Hence we may fufpect fomething of the properties of the alcaheft. It renders all metals diftillable by the retort, without altering their gravities; and again reftores them almoft without any alteration of their properties: this matter deferves to be farther inquired into. The oil here affords a highly expeditious cauftic in chirurgery, when carefully ufed. This procefs is efteemed a great fecret. Whilft performed, let the fumes be carefully avoided: I knew them once prove mortal to a very excellent and eminent perfon; therefore again, let them be carefully avoided.

PROCESS CCXXIII.

The mercurius vitæ *of antimony, and its* regulus.

'INTO a glafs of fair water let fall a drop of the rectified oil of antimony of the preceding procefs; the moment it falls it becomes white, turns to powder, and finks to the bottom of the veffel. Continue to drop in

'more,

'more, till a fourth part of the oil be ufed in refpect to the water; it in-'ftantly finks to the bottom, in form of an exceeding white ponderous pow-'der. Stir all with a glafs rod, let them reft, a limpid acid liquor will float 'above, which is gently to be decanted; perfectly edulcorate the powder, 'by wafhing it in feveral frefh waters, till it is entirely infipid; dry it with 'a gentle fire, and thus there will be obtained a white, infipid, ponderous 'powder, called *mercurius vitæ*.

The ufe.

Hence we fee the acid of fea-falt adheres to the regulus of antimony only whilft it remains very ftrong, but prefently quits it, and is attracted into the water, when diluted with a large proportion thereof. This powder, being given in the quantity of two or three grains, is violently emetic; whence fome, on account of its tragical effects, have called it *mercurius mortis*. If it be for a long time expofed upon glafs to a gentle fire, and kept conftantly ftirred, it lofes of its violence, becomes lefs active, and is by many faid to be the fecret of *Riverius*. This powder contains not the leaft mercury, but is a pure regulus of antimony. I took eleven ounces of *mercurius vitæ*, which I had prepared my felf, and put it into a ftrong large crucible in a blaft-heat; the powder melted, as foon as the crucible was thoroughly ignited; then pouring it into a melting-cone whilft it run thin, I had ten ounces of regulus, confifting of wonderful denfe fhining needles, but fomewhat greyifh.

PROCESS CCXXIV.

The philofophical fpirit of vitriol.

'FILTER the limpid acid liquor of the preceding procefs, infpiffate 'it to a half, and the philofophical fpirit of vitriol is obtained.

The ufe.

This limpid liquor is gratefully acid, has the tafte of fpirit of fea-falt, and, like that, may be employed perfectly with the fame effect, both in chemiftry and medicine. It is no way emetic, but a pure fpirit of fea-falt, that ftill retains its nature thro' fo many operations with mercury-fublimate, the butter and oil of antimony, and water, even without being fouled therewith, but ftill remaining a wholfome acid. It is improperly called fpirit of vitriol, as containing nothing thereof; for with the alcali of tartar it regenerates fea-falt again. I cannot but admire, and be pleafed with fea-falt in chemiftry; and being defirous to know the nature of this production, I diftilled a large quantity thereof in a tall glafs body, and found nothing left at the bottom, the liquor coming over extremely pure. Therefore the water thus inftantly drew out the fpirit from the butter of antimony, by being barely poured thereon, fo as to leave not the leaft antimony in the fpirit, which being before mixed with the regulus, rofe in the form of butter by the retort. I again diftilled all this liquor in a tall glafs body, and the third time with the gentle heat of about a hundred degrees; when there arofe a pure water, without

any

any manifeſt acidity to the taſte; and continued with this degree of heat, till nothing more would come over. I urged the remainder with a ſomewhat ſtronger fire, till a tartiſh liquor aſcended. I kept apart all that could be thus raiſed, under the title of the acid phlegm of the philoſophical ſpirit of vitriol, which is of good ſervice where gentle acids are required. I diſtilled the remaining liquor in a glaſs-body, and found it a highly acid, ſomewhat ſmoaking, but exceeding limpid and fat ſpirit of ſea-ſalt: and thus I learnt the wonderful nature of this ſalt, how eaſily it would unite, and how eaſily ſeparate.

PROCESS CCXXV.

Helmont's *flowers of antimony.*

'TAKE a pound of antimony, diſſolved in *aqua regia* according to the 'two hundred and eighth proceſs; put it into a low glaſs with a wide 'mouth; ſet it for a conſiderable time over a gentle fire; ſtir it conſtantly 'with a glaſs rod, till the matter becomes entirely dry; grind it in a glaſs 'mortar with a glaſs peſtle to fine powder; add an equal weight of dry 'ſal-ammoniac in proportion to the calx of the antimony; grind them together, the longer the better, that they may be thoroughly mixed; put 'the matter into a low glaſs-body with a wide mouth; clap on a capacious 'and clean alembic-head; lute the juncture with a mixture of linſeed-meal 'and water; ſet the body in a ſand-furnace with its pipe a little ſtooping, 'that the water which riſes in the ſublimation may eaſily fall into the receiver applied; raiſe the ſand up to the rim of the alembic; then make a 'gentle fire, and increaſe it by degrees. There firſt comes over a limpid 'acid water, which is all made to riſe by increaſing the fire a little; the fire 'being raiſed again, a whitiſh matter begins to appear, at which time the 'fire is to be kept ſo ſtrong, that the hand can ſcarce endure the heat of the 'glaſs-head, in which almoſt all the known kinds of colours will appear. This 'fire being continued eight hours affords a beautiful ſight, as if the head 'was painted of various colours. Let all cool gently; take out the body, 'and wipe both that and the head clean from any external duſt or foulneſs; 'take off the head, but beware of the firſt fume. Nearly the whole antimony will appear raiſed with the ſal-ammoniac into a variegated matter; 'take it out quick, and put it into a hot dry glaſs, under the title of *Helmont*'s ſaline flowers of antimony. They are violently emetic, even in the 'ſmalleſt doſe. There remains ſomething at the bottom, which may be 'ſublimed with more ſal-ammoniac. 2. Put theſe flowers into water, the 'water will turn milky; mix them well together, then let them reſt; a ſaline 'ammoniacal liquor will float above, which is to be decanted; waſh the 'flowers till they become perfectly inſipid; dry them by a gentle fire, and 'there will be obtained a ſubtile, red, highly emetic and inſipid powder, 'called *Helmont*'s dulcified emetic flowers of antimony. The ſeveral waters 'being inſpiſſated reſtore the ſal-ammoniac, fit for the ſame uſe.'

The use.

Here we have an example of the method wherein *Paracelsus* imagined, that a chemical death and resurrection opened the bodies of metals, for exerting their power upon the human body. Thus what is fixed becomes volatile, and all kinds of pigments are made. Here the black powder of the antimony is the crow's head, the white calx thereof the swan's neck, and all the beautiful colours taken together are the peacock's tail; and every one of them is emetic.

PROCESS CCXXVI.

Helmont's *fixed diaphoretic flowers of antimony.*

'TAKE one part of the dulcified flowers of the preceding process, and 'three parts of pure dry nitre; grind them thoroughly for some time 'in a glass-mortar; throw a little of this heated mixture into a clean cru-'cible, kept ignited in the fire; it will thus flame, though weakly. After 'the flash ceases throw in more; and thus continue till all the matter is de-'flagrated. Let all cool; a white yellowish substance will be found in the 'crucible; take it out carefully, grind it, wash it with water, dry it, it will 'thus become a fine white powder; put it into a china vessel, burn alcohol 'upon it, and keep stirring the powder with a tobacco-pipe, so long as the 'alcohol flames; and this ceasing, the powder is *Helmont*'s diaphoretic; 'thirty-six grains whereof are said to cure all intermitting and continued 'fevers by sweat.

The use.

Here again we have an example of fixing a volatile matter for chemical uses. This diaphoretic is highly exalted by its author. I have often made and used it, but could never find it had such excellent virtues as he relates of it in his *Aurora Medicinæ*, written in *Dutch*; whence I believe he was also somewhat too profuse in praising his other remedies.

PROCESS CCXXVII.

Helmont's *purging* diaceltatesson, *from the fixed flowers of antimony.*

'1. TAKE eighteen grains of the fixed diaphoretic antimony of the 'preceding process, sixteen grains of the rosin of scammony, and 'seven grains of cream of tartar; make them into a fine powder. 2. Or 'take nine grains of fixed diaphoretic antimony, nine grains of rosin of scam-'mony, and three grains of cream of tartar; make them into a fine powder. 'This is the description of *Helmont*'s purging powder, called *diaceltatesson* by '*Paracelsus*. The former is the largest dose for a grown person, and the 'latter the least. They are to be taken without any acid: if they operate 'too violently, the operation may be stopped by taking any acid. This

'powder

'powder being given in intermittents, ſo as to finiſh its operation immediately before the fit, is ſaid by its author conſtantly to cure quartans, before the fourth doſe, and all intermittent and continued fevers (*a*).

The uſe.

We have here another example of a chemical ſecret, of which *Helmont* ſays that it radically cures the gout and fevers; that it heals ulcers of the *larynx*, *œſophagus*, and bladder; that it purges the body, when imperfectly healthy, and not otherwiſe. He adds, in the *Latin* edition (*b*), that the doſe is eight grains; whence it appears, that the *Dutch* account is different from the *Latin*. I always ſuſpect that this great man carried the power of his ſecrets, by the ſubtlety of reaſoning, beyond what is warranted by experience. I have often prepared theſe powders with my own hand, and given them; but never could obſerve any ſuperlative, tho' always good effects.

And here I finiſh the ſet of proceſſes propoſed. I have kept to the deſign of exhibiting thoſe which were ſufficient for underſtanding the reſt: I will now add an Appendix concerning certain operations in Phyſics and Medicine; and theſe operations may be underſtood from the preceding proceſſes, by a ſhort recapitulation.

APPENDIX.

Chemical Solution.

1. SOLUTION is performed with water; by diluting, infuſing, boiling, diſtilling, mixing, fermenting, putrefying, and ſeparating.

2. With oil; by diluting, infuſing, boiling, diſtilling, mixing, ſeparating; but not by fermenting, or putrefying.

3. With fire; by calcining, roaſting, burning, melting, ſubliming, mixing, ſeparating, and promoting other operations.

4. With the aſſiſtance of the air; by fermenting, putrefying, agitating, exciting, and adding other parts capable of diſſolving.

5. With fermented ſpirits; by diluting, infuſing, boiling, diſtilling, mixing, and making oils thinner.

6. With alcaline ſalts; by calcining, torrefying, burning, melting, mixing, and ſeparating, according to the various force of a dry fire employed.

7. With volatile alcaline ſalts; by ſubliming in the dry way; and by diluting, digeſting, and diſtilling in the moiſt one.

8. With fixed alcaline ſalts, aſſiſted and moved by water and fire; by digeſting, boiling, diluting, ſeparating, and mixing.

9. With fixed acid ſalts; as thoſe of alum, ſulphur, and vitriol, either ſeparately in a liquid form, or in their calxes, by diluting, boiling, diſtilling, digeſting; or in a dry form, by calcining, roaſting, burning, or diſtilling.

(*a*) See *Helm. Aurora Medicin. Belgicè edit.* pag. 187, 188, 288.

(*b*) Pag. 775, 776.

10. With volatile acid ſalts; by diluting, digeſting, diſtilling, and inſinuating.

11. With compound ſalts and ſoaps; by calcining, ſubliming, diſtilling, and digeſting, either in a dry or liquid form.

12. With metals, by fuſion and amalgamation.

Chemical Coagulation.

1. COAGULATION is performed with water; by congealing, cryſtallizing, and precipitating, as in the *mercurius vitæ*.

2. With oil, which by the force of fire unites to itſelf ſulphur, ſalts, and metals.

3. With alcohol; upon the volatile ſpirit of ſal-ammoniac, the white of eggs, the ſerum of the blood, and oil of vitriol.

4. With alcali and acid, growing ſolid together; as particularly in the tartar of vitriol.

5. With fixed alcali; as in milk.

6. With acid ſalts; as in milk, ſerum, and white of eggs.

Chemical Precipitation.

THIS action is a manifeſt ſeparation of a body diſſolved, and made to depart from its ſolvent upon the mixture of ſome new thing. The operation is of great uſe, and deſerves to be carefully conſidered, and has been frequently obſerved in the proceſſes.

1. It is performed by water poured to oils diſſolved in alcohol, where the liquor turns milky.

2. With water poured to ſolid reſinous bodies in alcohol, where alſo the liquor turns milky.

3. With water in the diſtillation of oily ſpirits, if at the end any water run after the ſpirit is drawn off.

4. With acids by acids; thus ſilver and mercury are precipitated out of ſpirit of nitre by ſpirit of ſalt.

5. With metals by metals and other bodies. Thus, for example, dilute an ounce of ſilver, diſſolved in ſpirit of nitre, with twelve times the quantity of rain-water; put poliſhed plates of copper into the liquor, the ſilver will be preſently precipitated, and the copper diſſolved. Put this ſolution of copper into another glaſs, and add to it poliſhed plates of iron; the copper will preſently be precipitated, and the iron appears caſed over with copper; the copper falls to the bottom, and the iron diſſolves. Pour the ſolution of iron into a freſh glaſs, and drop into it oil of tartar *per deliquium*; the diſſolved iron immediately falls to the bottom, the alcali unites with the acid, and regenerates true nitre, after ſo many changes. And thus the ſoul travels from one body into another almoſt unaltered; tho' it is more attracted by one than by another, till at length it reſts in that which in this reſpect is the ſtrongeſt, and is only thence expelled, as when oil of vitriol is poured upon nitre thus regenerated. And upon theſe two principles precipitation depends,

pends, which is the true, and often abſtruſe cauſe of numberleſs operations, both in art and nature. Take a grain of white or red mercury-precipitate, rub it upon the ſurface of a poliſhed and heated copper-plate, which will thus immediately ſhine like ſilver; for the copper attracts the acid of the nitre from the calx of mercury, and thus preſently makes an amalgam upon the ſurface of the copper, and then acquires a ſilver colour.

6. Alkalies often precipitate things diſſolved by acids. This happens frequently, but not always, nor in perfection. Alcali precipitates copper diſſolved by an acid; but the copper is afterwards diſſolved by a ſalt made of the two.

7. Acids generally precipitate things diſſolved by alcalies; but in this caſe alſo there are ſome exceptions.

8. Sharp ſalts without being changed, and lying perfectly concealed, have ſtrange and unexpected effects, by means of precipitation. If an ounce of *luna cornea*, which is perfectly ſcentleſs, inſipid, and inactive, and affords no ſign of acrimony in the fire, be ground or united, by a ſtrong heat, in a glaſs-retort, with half an ounce of inodorous and perfectly inſipid regulus of antimony, there inſtantly ariſes an exceeding ſtrong poiſon, or an extremely corroſive butter of antimony, the exhalation whereof proves mortal. Whence we ſee how dangerous the art of mixing is, and what caution ſhould be uſed in the compounding of bodies.

Chemical Effervescence.

1. A SUDDEN agitation ariſing upon the bare mixture of two bodies, which lay at reſt aſunder, is called effervesſcence. This ariſes various ways; we ſhall here mention a few, which may ſerve to illuſtrate the reſt.

2. The principal bodies in which effervesſcence happens, are, (1.) Native vegetable acids, as moſt juices of trees, ſhrubs, and plants that run in the ſpring; moſt juices of unripe ſummer-fruits; particular juices remaining acid when ripe, as of oranges, citrons, lemmons, tamarinds, ſorrel, wood-ſorrel, and crabs; fermented acid vegetables, the meals when they turn ſour, *Rheniſh* and *Moſelle* wine and tartar; vegetables twice fermented, native and diſtilled vinegars; the acids of animals from tartiſh or acid vegetable aliment, as in the chyle, ſour milk, whey, butter-milk, and the whey thereof; the native acids of foſſils, as the acid of ſulphur, alum, or vitriol; or theſe acids as they lye concealed in ſulphur or vitriol-ſtones, or as thence extracted by a violent fire, or a ſtronger acid, as in the ſpirit of nitre, ſalt, alum, vitriol, and ſulphur.

3. True fixed alcalies made of any vegetable matter by burning; the more volatile alcalies, whether ſpontaneous, as in garlic, onions, ſcurvy-graſs, muſtard, &c. produced by putrefaction from animal or vegetable ſubjects, or procured from the ſame by diſtillation and burning.

4. Certain bodies improperly called alcalies, only on account of agreeing therewith in fermenting with acids; theſe are almoſt all the boles, bones,

 chalk,

chalk, clays, coral, crabs-eyes, earths, horns, hoofs, nails, pearl, ſhells, ſtones, and teeth.

5. The ſeven metals.

6. The ſemi-metals, antimony, biſmuth, *lapis calaminaris*, *lapis hæmatites*, lime, *&c.*

7. Hence we have four general rules, *viz.* (1.) The bodies of the firſt claſs almoſt conſtantly make an effervefcence with thoſe of the ſecond and third, either ſooner or later, more or leſs, or as they are weak or ſtrong. The effervefcence continues till the point of ſaturation is gained, then ceaſes, and the acrimony, after a full ſaturation, is generally ſoftened. (2.) The bodies of the firſt claſs make an effervefcence with thoſe of the fourth, tho' only ſome with others, and not univerſally, ſome ſtronger and ſome weaker; and at the end of the ſaturation vitriols are uſually produced. (3.) The bodies of the firſt claſs act in the ſame manner with thoſe of the fifth. (4.) The bodies of the ſecond, third, fourth, and fifth claſſes, being mixed together, are ſcarce found to make any effervefcence. Hence acids have this effect in particular along with the reſt; tho' here alſo it is limited. The beſt ſpirit of vinegar poured upon oil of tartar *per deliquium* makes no effervefcence at firſt, but does afterwards, and weakens the alcali.

8. Pure volatile alcali, well freed from its oil, makes an effervefcence with pure diſtilled vinegar: but much more cold than heat here ariſes; whereas other effervefcences uſually produce various degrees of heat, up to that even of actual flame. This extraordinary experiment ſhews, that apparent motion may be increaſed, and attended with cold *. Other effervefcencies are almoſt ever attended with heat †.

9. There are ſome moiſt and cold bodies which produce fire upon the inſtant of mixture. Put a drachm of recent diſtilled oil of cloves into a dry and hot urinal, ſet it under a chimney, and pour to it all at once two drachms of *Glauber*'s ſtrong ſpirit of nitre, upon the contact there inſtantly ariſes a terrible effervefcence, with thick fumes, poſſeſſing the whole cavity of the glaſs, a true and very red flame appearing in the middle: and, when the effervefcence is over, an extremely light and ſpongy matter is found left behind ‖. In this caſe a very powerful acid, eſpecially that of nitre, and a very rich oil concur, and not an alcali and acid. Mr. *Homberg* has explained the other effervefcencies, ſome of them burning, and ſome almoſt burning ‡.

10. There alſo ariſes a ſpontaneous effervefcence betwixt two hard and cold bodies, *viz.* Iron and ſulphur ground together, and brought with water into a paſte, which will take fire, and even flame.

* See the chapter of Fire, and Philoſ. Tranſact. *Lowth.* Abridgm. Vol. III. p. 354, 356.

† See the chapt. of Fire, p. 365——379.

‖ See Philoſ. Tranſact. *Lowth.* Abridgm. Vol. III. 353——365, and *Hoffman.* Diſſert. Phyſ. Chym. p. 38——45, and 126.

‡ See Memoir. de l'Acad. Roy. ann. 1701. p. 84, 95. & ann. 1708. p. 2.

A short recapitulation of the doctrine of Acid and Alcali.

ALCALI is either a fixed or volatile salt. It is known, (1.) From its origin, by the means of fire, putrefaction, or mixture. (2.) From its matter, whether vegetable, animal, or fossil. (3.) By its effect, or making effervescence with acid, precipitating, uniting with oil, especially a solution of sulphur; by changing the colour of the sun-flower, roses, or violets to green; whereas these change red with acids; by its taste, and by the burning pain it gives.

ACID is a fixed, or volatile salt, and known, (1.) from its origin, whether native, by fermentation, or by fire. (2.) From its matter, whether vegetable or mineral. (3.) From its effect, or effervescence with alcalies, earthy bodies, shells, corals, *&c.* by precipitating, turning neutral with alcaline and terrestrial bodies; by dissolving, especially the mercurial part of metals; changing the colour of sun-flower, roses, and violets to red; by its taste and odour, and the gnawing, darting pain it occasions.

This doctrine can scarce deceive much, but should not be rashly extended. It is erroneous to infer the existence of alcali or acid by any one physical character, which is common to other things, and even to those where any alcali is present. For example; it is a false conclusion, that because alcali makes an effervescence with spirit of nitre, but silver makes an effervescence with nitre, therefore alcali and silver are the same thing. And yet we every where find great men committing this childish error; so that they give every thing the name of an alcali, which makes an effervescence with any acid. This is a gross absurdity. Gold makes an effervescence with the acid spirit called *aqua regia*; therefore, they say, gold is an alcali: but it makes no effervescence with the acid spirit of nitre, and therefore it is no alcali. But these errors are infinite. It is a strange empty notion, to introduce acid and alcali for explaining the nature of all things; and yet we have seen the time when this doctrine has been triumphant, and thought the glory of the age. Let Mr. *Boyle* and Doctor *Bohn* be consulted upon this subject.

The production, destruction, and change of Tastes and Odours.

WE have seen these changes from our first process to the last; and there is scarce any one wherein something of this has not appeared. See Mr. *Boyle* in his treatise of the production of sensible qualities.

The production, destruction, and change of Colours.

1. ANtimony, of itself, is black when ground; of a greenish yellow when calcined with *aqua regia*; white, red, yellow, greenish, and black, when sublimed with sal-ammoniac; of an uniform red, when freed from its salt with water, but white when fixed with thrice its weight of nitre. Thus we have almost all colours in one solid body. Quicksilver dissolved by *aqua fortis*, and distilled in a glass-retort, affords in different parts of the glass different colours.

2. To

2. To produce a black colour, by pouring a pellucid liquor into a clean glaſs. This is done by rinſing a clean hot glaſs in a ſtrong ſolution of the vitriol of iron, then pouring therein a warm infuſion of bruiſed white galls in fair water, made ſo weak, as ſcarce to afford any colour. Thus a black mixture is inſtantly made. Inſtead of galls may be uſed red roſes, pomegranate-bark, tea-leaves, ſage, or oak-leaves, for the ſame purpoſes.

3. By the addition of a little white powder to turn a pellucid liquor black. Put a hot weak pellucid infuſion of galls into a glaſs, throw into it a grain of the vitriol of iron calcined to whiteneſs, and heated. This, where it falls, makes a black cloud, that, in a pleaſing manner, diffuſes itſelf thro' the tranſparent liquor, and gradually turns it black all around.

4. The ſame is done by the addition of a little yellow powder, by uſing as much vitriol calcined to a yellow colour, or elſe the yellow *ens veneris*.

5. The like may be done with a little red powder, by uſing the colcothar of vitriol calcined to redneſs, or the red *ens veneris*.

6. To do the ſame by the addition of a pellucid drop: let fall a drop of the aqueous ſolution of the vitriol of iron into the hot ſolution of galls.

7. To do the ſame with a drop of gold-coloured liquor; uſe the golden tincture made with the red calx of the vitriol of iron, with the dulcified ſpirit of ſalt. In all theſe experiments, whilſt the liquor changes from limpid to deep black, there ariſes almoſt innumerable ſhades, or intermediate colours, which at length all terminate in black.

8. The black colour, produced in all the ſix preceding caſes, may be brought back to pellucid again, by pouring the black liquors hot into a glaſs rinſed with the pure oil of vitriol, which attracts the iron: but the black liquor made with the *ens veneris* remains ſomewhat reddiſh; and ſo does that with the calx of iron, whilſt they tend to tranſparency.

9. To make theſe tranſparent liquors black again, pour as much hot oil of tartar *per deliquium* thereto, as may ſaturate the acid which had attracted the metallic matter: this happens with an effervescence, which in the mean time reduces, deſtroys, and regenerates viciſſitudes of colours. This is beſt perceived by letting the alcaline liquor fall in at ſeveral times, but quick.

10. Again; if a ſufficient quantity of acid be added to the black liquor thus regenerated, ſo as to aboliſh the alcali, the whole becomes pellucid again: and thus the blackneſs may be reciprocally deſtroyed and regenerated. Hence appears the incredible power of a metal to produce blackneſs; and how little matter is required to the production of colours. And hence, by a careful eye, may be obſerved numerous intermediate colours betwixt limpid and deep black.

11. To generate a colour by pouring a limpid liquor into a clean glaſs. Take a ſtrong ſolution of quickſilver made with ſpirit of nitre, dilute it with water, pour it into a hot glaſs rinſed with ſtrong ſpirit of ſea-ſalt. A very dilute ſolution of ſilver made in ſpirit of nitre, poured into a like glaſs, and the oil of antimony poured into a glaſs rinſed in hot water, does the ſame.

12. To

12. To produce an orange-colour, by pouring a pellucid liquor into a clean glaſs. Pour hot water upon new-made *crocus metallorum*, and put it into a clean glaſs rinſed with an acid.

13. To make a gold-colour by pouring a limpid liquor to a grey powder: Pour hot alcohol to ſulphur melted with fixed alcali, then ground and made hot.

14. To change the preceding gold-coloured liquor into a milky one, by pouring it into a clean glaſs. This is done by putting the preceding tincture into a glaſs rinſed with oil of vitriol.

15. To turn an almoſt limpid liquor blue. Pour ſpirit of ſal-ammoniac to a ſolution of verdigreaſe in vinegar, and dilute it with water till it be almoſt limpid.

16. To turn a blue liquor pellucid: Add acid to the preceding mixture, till the acid predominates.

17. To turn a very green liquor of a beautiful violet-colour. To a high green ſolution of copper in vinegar, drop ſpirit of ſal-ammoniac, till the alcali predominates.

18. To turn a blue into a beautiful green. To a rich ſolution of copper in ſpirit of ſal-ammoniac, add vinegar, or any other acid, till the acid predominates.

19. To produce numerous blues, and greens betwixt a deep blue and a deep green. Put a ſtrong and hot ſolution of copper in ſal-ammoniac, into a clean cylindrical glaſs; add thereto, ſlowly, ſpirit of nitre by a drop at a time; and a different colour between the two degrees aſſigned will appear upon the addition of each drop.

20. But for this ſubject of colours, Mr. *Boyle* has beautifully proſecuted it by experiments in his book of Colours. It is enough for me to have produced a few examples: and here I conclude the whole, and wiſh it may redound to the ſervice of mankind.

F I N I S.

APPENDIX.

Advertiſement.

THE author having chiefly confined his ſett of proceſſes to the ſervice of medicine; ſtudents are hence too apt to imagine themſelves poſſeſs'd of the elements of chemiſtry at large. In order to ſet this matter right, and at the ſame time do juſtice to the art, it has been thought proper to add the two following eſſays, by way of appendix, to ſhew the general nature, or great extent of chemiſtry.

ESSAY I.

An ESSAY, *for the farther* Advancement *of* CHEMISTRY.

INTRODUCTION.

1. A Conſideration of chemiſtry, in its proper extent and neceſſary relations, may perhaps ſhew it to be of that uſe in life, as to deſerve a particular regard. *Chemiſtry not to be diſregarded.*

2. Chemiſtry may be conceived as the buſineſs of changing the internal ſtructures, or ſenſible qualities, of all the bodies produced by nature, by art, or by accident, in this globe of ours; with a view to ſearch into their ſecret relations, ſo as to find out ſome new properties or uſes thereof, and thence increaſe our knowledge of theſe bodies, or render them, one way or other, more ſerviceable in life. *General definition.*

3. If this deſcription be juſt, it will follow, that whoever would underſtand the import and buſineſs of chemiſtry, muſt view and conſider it in a ſtate of action and manual operation; or, as it practically contributes to enlarge the underſtanding, ſupply the neceſſities, and afford the conveniences of life: which is the light wherein the Lord *Verulam*, and Mr. *Boyle* have juſtly placed it.

4. To give a fair and full repreſentation of chemiſtry, in ſo extenſive a view, muſt be the work of ages: and before any ſtep can be taken in it to ſatisfaction, the ſubject requires a diviſion into ſeveral branches; each whereof being gone over a-part, may give ſome general notion of the whole.

5. The moſt uſeful diviſion ſeems aptly to fall under the comprehenſive heads, or titles, of philoſophical, technical, commercial, and œconomical chemiſtry. *And general diviſion of the art.*

SECT. I.

Of Philoſophical CHEMISTRY.

Philoſophical chemiſtry explained.

1. PHiloſophical chemiſtry is that particular part, which, contented with things entertaining, ſatisfactory, and inſtructive to the mind, does not directly and ſollicitouſly endeavour after ſuch as are immediately uſeful, or advantageous.

2. In this view, philoſophical chemiſtry will conſiſt of three parts, *viz.* invention, rationale, and experiment: whence it might be defin'd, the particular exerciſe of the inventive and rational faculties of the mind upon chemical ſubjects, operations, and effects, leading up to experiments and back again; ſo as to draw concluſions, explain phænomena, ſtart problems, and attempt their ſolution, in this circle ſucceſſively.

And divided.

3. Philoſophical chemiſtry, therefore, is the ſource and ſoul of the whole art; as by inventing, reaſoning, comparing, and adjuſting of things, directing experiments, and concluding from the reſult, it forms new doctrines, and makes new diſcoveries, for itſelf, and all the other branches, to improve and apply.

Applicable in the way of invention.

4. In the way of invention, this part of chemiſtry is more particularly applicable; (1.) To the imitation of natural and artificial things. (2.) To the production of new artificial bodies. (3.) To the ſtarting of new arts and trades. And, (4.) To the ſupplying of deſiderata, or defects in the old ones.

To the imitation of natural and artificial bodies.

5. (1.) Since natural bodies may be ſo reſolved, or taken to pieces, as, in many caſes, to diſcover their conſtituent parts, or ingredients; philoſophical chemiſtry hence forms rules for imitating various productions of nature: which, in ſome particulars, is done to great exactneſs; as in the making of cinnabar, vitriol, *&c.* where the reſolution has been found eaſy; in others leſs exactly, where, by the common methods, the reſolution has hitherto proved more difficult; as in the buſineſs of artificial gems and metals. (2.) The like alſo is to be underſtood of artificial bodies, made in one country, and imitated in another; whence the imitation of *Venice*-glaſs in *England*, the imitation of porcellane, the *Japan*-varniſh, various refinements of foreign drugs, ſugar, *&c.* in *Europe*; all which, where not caſual, are of pure chemical extraction: and the proper enquiries into things of this kind, fall under the inventive part of philoſophical chemiſtry.

The production of new artificial bodies.

6. (3.) New artificial bodies are chemically producible *ab origine*, either in the way of ſeparation or combination. In the way of ſeparation, chemiſtry has invented and produced fermented potable liquors, inflammable ſpirits, ſalts, ſugar, pot-aſh, thoſe vulgarly call'd chemical preparations, as oils, extracts, ſpirits, *&c.* various pigments, and all the pure and unmix'd metals: and in the way of combination, it has produced ſoap, glaſs, vitriol, gun-powder, all the mix'd or artificial metals, *&c.*

7. (4.) Arts and trades are the genuine fruits or conſequences of the preceding diſcoveries: in which view inventive chemiſtry is the purveyor to all the other branches; and has thus ſtruck out a very large number of hints, which are frequently form'd into trades. Thus the invention of *aqua fortis*, for example, has given riſe to the ſcarlet-dye, the buſineſs of etching, the art of refining, *&c.* *The ſtarting of new arts and trades.*

8. (5.) And as inventive chemiſtry thus ſtrikes out new arts and trades, 'tis no leſs capable of diſcovering means to promote them, or ſupply the defects which may appear in their firſt eſtabliſhment, or retard their farther advancement. Inſtances of this kind are every where to be met with; particularly in the arts of ſugar-baking, ſoap-boiling, brewing, diſtilling, *&c.* wherein many ſhorter and better methods of working have hence been ſeverally diſcover'd. *And ſupplying their deſiderata.*

9. In the way of rationale, philoſophical chemiſtry is particularly applicable; (1.) To the accounting for natural and artificial phænomena, and effects. (2.) To the explanation of the general and particular properties, or forms and qualities, of bodies. (3.) To the diſcovery of the chemiſtry of nature. (4.) To the conſideration of natural and artificial tranſmutations. And (5.) To the giving a rational theory of medical matters. *Applicable in the way of rationale.*

10. (1.) Philoſophical chemiſtry accounts for many natural and artificial phænomena and effects; as it is often in the power of this art to imitate the ſame: and thence, reaſoning by juſt analogy, it may be allow'd to give fair and ſatisfactory ſolutions. After this manner it endeavours to account for lightning and thunder, with their ſurprizing effects; the *aurora borealis*, earth-quakes, vulcano's, *&c.* And in the ſame way it ſolves the phænomena of gun-powder, the *phoſphori*, and various other unexpected productions of chemiſtry itſelf. *To the ſolving of natural and artificial phænomena.*

11. (2.) As this part of philoſophical chemiſtry is uſed to explain the general and particular properties, or forms and qualities of bodies, it conſiders heat, cold, light, moiſture, dryneſs, volatility and fixedneſs, fluidity and firmneſs, continuity and contiguity, colours, taſtes, odours, congelation and conglaciation, efferveſcences, fermentations, putrefaction, ſolution, precipitation, and the various operations of chemiſtry, *&c.* ſo as to ſhew how they are produced, affected, altered, or changed in bodies; and thence draw out their general and particular hiſtories. *Giving the hiſtories of qualities.*

12. (3.) Philoſophical chemiſtry finds many reaſons for allowing a chemical agency in the production of natural bodies, and in their manner of acting upon one another; whence they bring about a kind of true chemical effects. And upon this foundation, the original compoſition and ſtructure of natural bodies is rationally accounted for; with the operations and effects of the elements upon each other. Thus water and air may be chemically conſidered as two grand menſtruums of nature, which by means of the ſun's heat, and the ſubterraneous warmth, are continually at work upon all ſublunary bodies, in order to bring forward various changes, regenerations and tranſmutations, *&c.* whence the origin and appearances of meteors, the generation of hail, ſnow, rain, metals, minerals, *&c.* And thus all nature's proceſſes of vegetation, animalization and mineralization may be conſidered and accounted for, as operations or effects of natural chemiſtry. *Diſcovering the operations of nature.*

Confidering of natural and artificial tranfmutations.

13. (4.) The bufinefs of natural and artificial tranfmutations falls the more particularly under the rationale of chemiftry, as little elfe befides confideration and reafoning is required to underftand and apply it. Thefe tranfmutations may be entirely natural, or entirely artificial; or partly natural and partly artificial. Under the entirely natural, come fuch as thofe produced by putrefaction, long ftanding or digefting in the air, water or any natural fluid; whence animal fubftances are converted into vegetables, wood into ftone, metals into one another, bodies into air, water, fire, *&c.* and thefe are again into bodies.

14. The tranfmutations effected by the joint concurrence of nature and art, are fuch as thofe made by fermentation; where art puts the fubjects together, and rightly difpofes them; but nature performs the bufinefs: fo in the making of paper, art ftamps the rags; but nature half putrefies the matter, and thus contributes to change it.

15. The tranfmutations purely artificial are fuch as thofe made by triture, mixture, long digeftion, and other chemical operations; as in extracting the mercuries of metals, and feveral other inftances of the fublimer metallurgy.

16. Whether thefe artificial tranfmutations be real or only apparent, is not fo much the queftion; thofe who will not allow them for tranfmutations, may call them alterations or changes of one form into another: and perhaps they may be no more at the bottom; for if the changed body be not always artifically reducible to its priftine ftate again, (which is fuppofed the criterion of an artificial tranfmutation) this may be owing not to any impoffibility in the thing; but to the want of a fuitable method for doing it.

And fettling the theory of phyfic.

17. (5.) A juft theory of many medical matters will naturally flow from the foregoing confiderations, or from a particular application of the rationale of philofophical chemiftry to the human body; with a view to obferve its natural ftate, its diforders, and the effects of remedies. Thus in particular it helps to clear up the difputes about animal digeftion, chylification, fanguification, nutrition, *&c.* and may fhew how the blood and humours are altered by heat, cold, motion, attrition, *&c.* whence the origin, nature, duration and phænomena of diftempers, and their manner of cure, might be rationally deduced.

Applicable, in the way of experiment, to the eftablifhing a theory of chemical matters.

18. In the way of experiment, philofophical chemiftry is univerfally applicable, and often abfolutely neceffary to the farther examination, illuftration and confirmation of the preceding parts, or the whole theory of the art; which cannot fubfift without it. For tho' fome kind of theory might be formed of philofophical matters independant of experiments; yet fuch theories have ufually been found barren, unfound or ufelefs, fo as in no refpect to be fafely trufted.

Bringing inventions to the teft.

19. It is the peculiar province of this part of philofophical chemiftry, to bring new inventions and theories to the touch-ftone; difcover their validity or their infufficiency; and when found juft and folid, to confirm or ftamp them with a character that makes them univerfally current, and fit to be employ'd for farther ufes.

The advancing of new trades.

20. Thus, when any hint is ftarted for a new trade, or chemical method invented for the improvement of an old one; before the leaft attempt is made

made to apply it in bufinefs, the proper effay or experiment muft be performed; which proving fuccefsful, upon repeated examination, with due variation of circumftances, may now encourage the application, or advancement of this difcovery into an art.

21. And thus philofophical chemiftry works in miniature, to try the truth, and find out the practicability of things; an example or model of which is preferved, and particularly retained, in the bufinefs of affaying; which before-hand determines the yield of an ore, and fometimes the beft way of working it in large, by previous experiments made in miniature. *And finding the practicability of Things.*

22. By thus confining it felf to work in fmall, or in the way of trial, enquiry or fpecimen, philofophical chemiftry has the opportunity of fully commanding its fubject; which it chufes of a proper fize for the external fenfes to view, and examine on all fides; and obferve the phænomena, effects and relations, without being oppres'd with too unwieldy a bulk, or having the mind diftracted with too many confiderations, which might attend a large work, and retard its advancement to a ftated perfection. *Advantages of philofophical chemiftry.*

23. But when thus the experimental part of philofophical chemiftry has perfected any difcovery, in fmall, with relation to arts or trades, and clearly fhewn how it may be wrought to advantage in large, it has now performed its office; and here leaves the thing, or turns it over to the other branches of chemiftry, whofe end is advantage, to be carried on in the form of a bufinefs. So *Cornelius Drebbel*, when he had fairly proved the invention of the fcarlet-dye, gave it up to thofe who afterwards exercifed it as a trade. And this appears to have been the general way wherein arts and trades were originally invented, or firft brought into ufe; for it cannot be fuppofed, that large expenfive works fhould have been fet up, before any trial had appeared to encourage them. *Contributes to eftablifh larger works.*

24. 'Tis a particular happinefs in this bufinefs of experiments, that when an enquiry is made by their means, a proper fett, or competent number of them, gone thro' in due order, will ufually give the difcovery, or as it were a fpontaneous folution of the problem. But to practife this method to advantage, requires a judicious head and a dextrous hand; with a due obfervance of the rules laid down by the Lord *Verulam*, in his *Novum Organum*. *In what manner to be profecuted.*

25. As the feveral parts of philofophical chemiftry are thus feparately applicable to fuch purpofes; much greater advantage may be reafonably expected from the joint ufe and mutual affiftance which they are capable of affording each other; efpecially by a prudent management and application. Much has been done in this way, but more remains to do. The Lord *Bacon* feems to have gone as far as poffible, without the affiftance of new experiments, in all the parts of philofophy, but principally in chemiftry; up to which his attachment to nature directly led him: but at the *fiat experimentum* he judicioufly chofe to ftop, rather than to advance farther by the help of conjecture, or fuppofing the event of experiments which it would require fome ages to make. As if the *fiat experimentum* had been directed to Mr. *Boyle*, this philofopher took up chemiftry where the Lord *Bacon* left it; and to what lengths he carried it, the prefent ftate thereof may witnefs. *The joint effects of all the parts of philofophical chemiftry.*

26.

Chemistry cultivated in Germany,

26. But the *English* philosophers seem at present to be got a little out of this chemical vein; and applying closer to other studies, leave the cultivation of chemistry to the philosophers of other nations. We have had our *Bacons*, our *Digbys*, and our *Boyles*; men as eminent in chemistry, as in other parts of knowledge: but *Germany* seems more disposed to encourage this art, where every court has its laboratory, and every mountain its mine; whence that country has been usually well supplied with original chemists; such as *Agricola*, *Ercker*, *Kunckel*, *Becher*, *Homberg* and *Stahl*.

And Holland.

27. Hence also their contiguous neighbours, the *Dutch*, have derived so much of this art as suits their purpose; and fits them to supply all *Europe* with commodities of great consumption, new fabricated and refined by their industrious hands. Nor has less industry been used of late, to promote the knowledge of this art in their Universities; and tho' it be there taught with a view to medicine only, yet some have hence taken occasion to launch a little into philosophical chemistry.

Extent and office of philosophical chemistry.

28. But not to leave this business of philosophical chemistry too loose, it may be necessary to curb and confine it within its own bounds; so as to keep it from entrenching upon the exercise of certain mechanic arts, or trades, on the one hand; and upon the common experimental philosophy on the other.

Distinguished from arts.

29. Philosophical chemistry seems sufficiently distinguished from the exercise of arts by the observation already made, of its being confined to work in miniature, by way of inquiry, trial and specimen only; whereas arts produce in large, upon a formed and settled discovery, to supply the demands of trade and the calls of commerce. So that, for example, there is the same difference betwixt a substance produced in a chemical experiment, and a commodity produced in the way of an art, as betwixt the assay of an ore in a private chamber, and the working of the ore for its metal in the smelting-huts. The distinction might otherwise appear from the invention, discovery and reasoning which constantly precede and direct all the original chemical experiments; but are wanting in the exercise of arts: which have all that done to their hand; and only consist in a repetition of the same uniform action, or operation.

From experimental philosophy.

30. The distinction betwixt philosophical chemistry and the common experimental philosophy lies here, that philosophical chemistry is the business of practically, or experimentally, examining into the internal structure and composition, not only of natural, but likewise of artificial and accidental bodies; separating their constituent parts, differently combining these again, and thus producing new concretes, and new modifying or changing both the sensible properties and the internal as well as external forms of the old ones; whereas the common experimental philosophy is employed in searching after and discovering the more general and obvious properties, or external uses of natural bodies; the gross integrant parts, or entire aggregates whereof it experimentally orders, arranges, disposes and applies, in their natural form and substance, to the promotion of knowledge, and the uses of life: but thus produces no new bodies, nor enters into the internal substance, structure, and composition of the old ones; nor changes their external and

internal

internal forms; nor separates their constituent parts; nor variously combines these afresh; nor regards bodies at all as they are resolvable and combinable, or as they are simples, mixts, compounds, aggregates or de-compounds: all which is the peculiar business and office of philosophical chemistry.

31. Thus again, 'tis conceived that natural philosophy cannot, with propriety, be said to extract and purify metals, analyse vegetable, animal and mineral substances, tan leather, brew beer, dye cloth, make glass, produce oils, spirits, soaps, &c. but all these are the direct and proper operations of chemistry. *And from natural philosophy.*

32. So, likewise, natural philosophy discovers the obvious, external and general properties of the air, fire, water, heat, cold, moisture, wind, &c. by means of various experiments, made with the air-pump and other suitable contrivances; but it is philosophical chemistry which more intimately and essentially examines into the internal nature, structure, composition, relations and uses of the elements; and thence finds ways of applying them as engines and instruments of business: and thus, in a more particular manner, it applies those two grand instruments, heat and cold.

33. In short, there seems to be nearly the same difference betwixt chemistry and the present natural philosophy, as there is betwixt art and nature; so that perhaps it might not be amiss, if by way of distinction, the whole of chemistry were allowed to pass under the name of artificial philosophy. *The whole of chemistry an artificial philosophy.*

34. This distinction might not only serve to restrain chemistry to its proper province, and settle a just notion of the extent and proper business thereof; but in some measure also contribute to remove the prejudice convey'd with the name, and thro' habit apt to arise in the mind upon all occasions, when chemistry is mentioned.

35. The immoral practices of many who have taken up the name of chemist, greatly contribute to bring a disrepute upon the art; whereto the abandon'd and the dissolute have usually made their pretensions, with no more knowledge of it, than would serve them to cheat dextrously under its appearance. And so odious has chemistry been render'd by this means, as to deter many from the study and exercise thereof; whence it has been too much left in bad hands. But the damage from this quarter is more sensibly perceived in the sublimer metallurgy; whence golden mountains having been too often seriously expected, the indigent and knavish pretenders to the art, have hence been furnished with a handle to practise upon the unwary, or such as they found actuated by superstitious credulity, or blinded by an immoderate passion for gain: insomuch that numerous and repeated abuses, flowing from this fountain, have occasion'd the instructive, and philosophical art of alchemy, to be currently esteem'd as a juggle, or a trick, on the one side; and as an infatuation or delusion on the other. *Whence the disrepute of chemistry.*

36. These, and the like abuses, are indeed no way justly chargeable upon the art it self, but entirely upon the artists; yet such is the fate of human affairs, that the faults of men are often laid at the door of the arts they profess; as those arts may prove occasional causes of the ill: whence chemistry perhaps gives more occasion of public and private abuses than other arts; as being less generally understood, and attended with the prospect of larger profits and advantages. *Whence its farther advancement retarded.*

37. But as the beſt things are capable of the greateſt abuſe, this miſapplication of chemiſtry could hardly, of it ſelf, have removed it from the care and patronage of the *Engliſh* philoſophers, if more tempting ſtudies had not come in the way; particularly the higher geometry, and ſpeculative philoſophy; which of late ſeem to have employ'd moſt of our great genius's. But if upon full examination theſe more ſublime ſtudies ſhall be found of narrow uſe; chemiſtry again may chance to be cultivated, as an art whoſe eſſence is action, and whoſe end is utility.

Reaſons for the revival of chemiſtry.

38. And if the genius of the *Britiſh* philoſophers ſhould in earneſt turn this way, the art it ſelf might thus be nobly reſcued from the hands of ſuch as diſhonour it; and be ſet in a true light, unſullied by chicane, impoſition or deluſion: new improvements would be daily made therein; many valuable ſecrets diſcovered; new trades advanced; commerce enlarged, and uſeful knowledge encreaſed. And tho' our philoſophers were to be thus employ'd for ages yet to come, no fear of exhauſting this rich mine of philoſophy and arts: which may be now dug to greater ſatisfaction and advantage, as there is no want of mechanical hands in *England* to execute in large, or bring into works, ſuch diſcoveries as ſhall give the encouragement. For, as much as the *Engliſh* philoſophers excel in contrivance, invention and accuracy of experiment; ſo much are our mechanical people allowed to excel in adroitneſs and truth of work. And ſince the new opening, draining and working of mines among us, we ſeem to be call'd upon afreſh to the exerciſe and improvement of this art; whence it may in time come to meet with that eſteem and application it deſerves in a country ſo juſtly famous as ours for its philoſophy and its trade; and thence one day appear in a due body and form of artificial philoſophy.

The aſſiſtance required thereto.

39. But ſuch a fabric cannot be erected without a number of hands employed upon the ſeveral parts; and indeed all the aſſiſtance that can any way be procured, is little enough for the purpoſe. Nor is it eaſy to ſay, before ſome farther advancement is made, what materials and what helps are wanting to carry on the work. It may not, however, be amiſs here to point out ſome of the more immediate deſiderata for the farther application and advancement of philoſophical chemiſtry; leaving the reſt to be ſpecified occaſionally.

Deſiderata of philoſophical chemiſtry; with the ways of ſupplying them.

40. (1.) And firſt, a method of facilitating the experimental part of philoſophical chemiſtry is greatly wanted; and may be ſupplied by the introduction of a ſmall apparatus for an extemporaneous philoſophical laboratory.

41. The difficulties, inconveniences and incumbrance that attend the erecting, procuring and uſing the common chemical furnaces and veſſels, have been found a conſiderable diſcouragement to the exerciſe of this art, in the way of experiment and inquiry; ſo that it might be of good ſervice, if a philoſophical or portable furnace were at all times eaſily procurable, for the ready and commodious performance of all the operations in chemiſtry; the furnace, with its apparatus of veſſels and inſtruments, being made capable of ſtanding, and working in a common room, or chamber, without danger. And whoever conſiders what has already been done in this way by *Glauber* and others, but particularly by *Becher* and *Vigani*, will not find reaſon to think ſuch an engine and apparatus impracticable *.

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* See the following Eſſay.

42. Along with this general portable furnace, and felect apparatus of veffels and inftruments, might go a fuitable collection of the more neceffary and ufeful parts of the *materia chemica*, ranged under proper claffes; with their defcriptions and more general ufes: and thus all the preparatory matters to the exercife of philofophical chemiftry, might, without farther trouble, be put into every one's hands. *The materia chemica.*

43. (2.) In order to direct the more neceffary inquiries, it might be ufeful to have a juft fummary of all that is hitherto known and done in chemiftry, concifely drawn up, to fhew the prefent ftate of the art with regard to what is delivered in books. And this perhaps would be found an eafier tafk than it might at firft appear: for tho' the authors in chemiftry are exceeding numerous; yet the original experimental writers, who alone fhould here be regarded, are few in comparifon of the fpeculative theorifts, plagiaries and tranfcribers. The more difficult part of the work would be to collect from unwritten traditions; and defcribe the daily practices of mechanical operators in their ordinary bufinefs of fmelting, refining, affaying, tempering of fteel, working of glafs, boiling of fugar, preparing of colours, refining commodities, *&c.* All which require particular managements, that the workmen in moft cafes ftudioufly conceal. *Summary of the art.*

44. (3.) There is farther wanting, to the advancement of philofophical chemiftry, a fet of practical rules for conducting all the chemical operations, and teaching the neceffary encheirefes or managements. For tho' a hand cannot by fuch rules alone, without practice, be formed to bufinefs; yet the underftanding may be directed by them to procure the habit in the beft and fhorteft manner. And, befides the ufefulnefs of fuch rules to thofe unacquainted with chemical operations, they may be of farther advantage to perfons of experience; as the failure of particular experiments, in particular hands, feems principally owing to a neglect or non-obfervance of particular encheirefes; which, in delivering experiments, are fometimes omitted by defign, and fometimes by neglect or overfight. Thus the particular fuccefs of many experiments in the fublimer metallurgy, has been thought contingent; as thofe who endeavour'd to repeat them could not make them fucceed; but was afterwards found owing to in-attention, mif-conduct, or the want of a particular encheirefis, in fome part of the operation. And this kind of failure will frequently be found in chemiftry, without a particular fagacity, and dexterity, in the conducting of experiments, or without a deliberate and fober regard to encheirefes; which, in reality, make operations and experiments the things they ought to be. *Rules for operating.*

45. (4.) Another particular wanted to the advancement of philofophical chemiftry, is a general lift of the chemical defiderata, or defects, in all arts and trades; with fuitable conjectures at the readieft ways of fupplying them, upon folid and experimental grounds. And to this might be added, by way of appendix, a lift of hints for the introduction of new mechanic arts; upon the like rational and folid foundation: all which are a kind of problems, the folution whereof naturally belongs to the philofophical chemift. Thus in the iron-works, for example, it has been a defideratum to run metal from the ftone without bellows; another to make malleable iron with pit-coal; and a third *A lift of defects in arts.*

third to work it, or ſoften it for the hammer, without fire. 'Tis a deſideratum in the tin-works to get the ſilver out of tin, as 'tis now got out of lead. In the glaſs-works, 'tis a deſideratum to ſolder up the cracks or flaws in the pots, whilſt detain'd in the fire; and another to make glaſs without veins, *&c.* A taſteleſs and inodorous wine is wanted by the vintner; and a taſteleſs and inodorous ſpirit by the diſtiller. The painter wants a permanent green, and the callico-printer a permanent blue colour. In ſhort, all arts have their reſpective wants and defects. So, chemiſtry it ſelf is greatly defective in an experimental hiſtory of general fermentation, ſeparatory and combinatory, in ſubjects of all the three kingdoms; a hiſtory of putrefaction, rancidneſs, muſtineſs, mouldineſs, glews, mucilages, and a thouſand things of the like general nature. In particular, the ſublimer metallurgy wants a more facile method of extracting the mercuries of metals; and a cheaper one for meliorations: and all the other parts ſeem equally defective.

Hints for new trades.

46. The hints for new trades will riſe occaſionally, and almoſt without ſeeking. Thus 'tis natural, from the common operations of brewing and ſugar-baking, to ſuggeſt that ſugar may be procured from malt, and other vegetables; that nurſeries of peculiar ferments, native and foreign, may be rais'd, *&c.* The introduction of which new trades would alſo greatly alter and improve the arts of brewing, ſugar-baking, *&c.*

Communication of trials and ſecrets.

47. (5.) When a general knowledge is gain'd in the theory and practice of this art, ſo that its uſes and the manner of applying it to the purpoſes of life, are become ready and familiar; it ſeems principally neceſſary to its farther advancement, that there ſhould be a free communication of experiments and trials, among a ſelect number of perſons thus qualified: for, as it is ſcarce poſſible that any ſingle man ſhould have a competent knowledge in all arts and ſciences; ſo is it expedient, that as much as can be acquired ſhould be lodged in ſome few, who may freely draw out of each other: whence they might be enabled to furniſh, not jejune repetitions of things already currently known and practiſed; but reſults of new inquiries, new improvements, and methods of ſupplying the defects of particular arts, in the way of eſſays, well fraught with experimental facts, and uſeful diſcoveries.

48. Nor will ſuch a body of men fail of procuring all the aſſiſtance that can be had from uncommon books, papers, and accounts of particular facts, and experiments; even, from ſuch as relate to the making of malleable glaſs and philoſophical gold, down to the little œconomical obſervations of ſpots and tarniſh. The ſearch after the philoſophers ſtone has produced abundance of curious, and ſome very profitable diſcoveries: and the vulgar obſervation of iron-mould in linen has given origin to a fix'd and durable yellow, in the buſineſs of callico-printing. And in this manner, philoſophical chemiſtry ſhould be kept continually open, or in a ſtate of improvement; only permitting, as it advances, that arts and trades be ſupplied, detached, or drawn from it occaſionally.

SECT.

SECT. II.

Of Technical CHEMISTRY.

1. BY technical chemiſtry is underſtood the application of philoſophical chemiſtry to the immediate ſervice of arts; ſo as to invent, form, aſſiſt, promote and perfect them. *Technical chemiſtry.*

2. The chemical arts may be divided according to their ſubject-matters; or as they work upon animal, vegetable or mineral ſubſtances: whence the whole of technical chemiſtry will fall under animal, vegetable, mineral and mix'd arts. *Divided.*

3. To give a ſhort view of the method wherein this ſubject is propoſed to be treated, we ſhall here ſet down a few hints for the improvement of certain chemical arts; and firſt for thoſe exerciſed on animal ſubjects. *And apply'd.*

I.

Hints for the improvement of certain chemical arts exerciſed on animal ſubjects.

The art of preparing ſize and glew.

4. (1.) The manner of diſſolving the leather, and boiling the productions to their due conſiſtence; with the ways of caking and drying the glew. *Size and glew-making.*

(2.) The manner of preparing fine glews, from iſinglaſs, *&c.* for particular uſes.

(3.) An inquiry into the beſt methods of preventing the loſs of tenacity, from the long boiling of the glew.

(4.) The uſe of *Papin*'s digeſtor in the making of ſize and glew.

(5.) An attempt to prepare glews from ſome cheap vegetable ſubſtances, without much heat.

(6.) The manner of preparing and improving the fine animal glew, or pocket-ſoop.

(7.) The natural diſpoſition of all animal and ſome vegetable matters for turning to glews, ſhewn by experiments; with a philoſophical inquiry into this buſineſs, for laying the foundation of a natural and experimental hiſtory of glews, mucilages, ropineſs, viſcidity, ſizineſs, mouldineſs, *&c.* in animal and vegetable liquors; but particularly the blood, ſaliva, *&c.* wines, vinegars, *&c.*

The art of ſtaining and working in horn, bone and ivory.

5. (1.) The ways of ſoftening theſe hard animal ſubſtances; ſo as to render them capable of ſtamps, figures and emboſſinents, by moulds and preſſure. *Staining of horn, &c.*

(2.) The chemical preparations, mixtures and treatment required in this buſineſs; ſo as to give a beautiful and fix'd blue, yellow, red, green, and other perfect colours, to bone, ivory, and other animal ſubſtances.

(3.) The methods of bleaching, or whitening and ftaining of hair, as depending on the fame foundation; or the ways of turning hair of any colour at pleafure; but particularly from red to brown or black, from yellow to perfect white, *&c.* by means of chemical liquors, or chemical fumes, *&c.*

(4.) Ways of preventing the fplitting and cracking of thin horn and ivory-wares.

(5.) Hints for the more advantageous ufe of the horner's fhavings.

(6.) How far the proceffes for ftaining horn, hair and ivory are applicable to the ftaining of leather, wood, ftone or marble.

(7.) The experiments and improvements in this art applied to promote the philofophy, or practical doctrine, of colours.

The art of tanning, and dreffing of leather.

Tanning. 6. (1.) The beft manner of preparing the hides and fkins of animals, making the tan-liquor, putting them together, and drying the fubject.

(2.) The hiftory of the principal materials and ingredients employed in this art; their manner of preparing, extracting, condenfing and preferving for ufe.

(3.) An inquiry into fome farther ufes of the tan-liquors, and the refufe ftuff, after the operation is over.

(4.) The application of this bufinefs to the art of embalming, or preferving the flefh and other parts of animals, for certain purpofes, by a fuitable tan-liquor, and drying.

(5.) The ufe of this art in explaining the nature of corruption or putrefaction, either in general, or at leaft in animal fubjects; as it fupplies a fimple remedy to prevent it: and hence an inquiry into the methods of applying it to other ufeful purpofes.

The art of the fkinner.

Skinnery. 7. (1.) The beft ways of preparing and preferving the fkins of beafts and birds; with their natural furs and plumage.

(2.) How far this art co-incides with the art of tanning; and how far it is improveable by the arts of ftaining and dying.

(3.) The ufefulnefs of this art in the bufinefs of anatomical preparations; and that part of natural hiftory which more particularly relates to animals.

The art of curing and preferving the flefh of animals for food, both in a dry and a moift form; or by fumes, falts, and pickles; without indurating the fubject too much, deftroying its natural relifh, or rendring it too faline.

Preferving flefh. 8. (1.) The improvements to be made in this art by the due ufe of fugar, nitre, and fome diluted acid fpirits.

(2.) The *Dutch* manner of pickling herrings; and the principle whereon its fuperior excellency depends.

(3.) The *Englifh* manner of preparing red herrings; and the principal methods ufed in our own country to preferve provifions both at fea and land: with various improvements in thefe particulars, by the ufe of certain chemical or compound liquors, and particular managements.

The

The art of preparing, purifying and meliorating animal fats; as tallow, train-oil, ſperma ceti, &c. ſo as to render them fit for the finer uſes.

9. (1.) Inquiries after ſome particular methods of taking off the nidorous odour, and rankneſs of the groſſer animal oils and fats; ſo as to render them ſweet and fit, in ſome caſes, to ſerve inſtead of vegetable oils and wax. *Refining fats.*

(2.) Methods advanced to edulcorate train or ſeal-oil, for the uſes not only of the clothier, ſoap-boiler, &c. but to anſwer the ordinary purpoſes of oil-olive.

(3.) A particular inquiry into the method of purifying butter by ſeparation, and converting it into a durable and perfect ſallad-oil.

(4.) The ſperma ceti candles improv'd.

The art of dying in wool and ſilk.

Preliminaries.

10. (1.) An account of the *materia tinctoria*, dying ſtuffs or dry-ſalters wares; with ſo much of their natural hiſtory as relates to this buſineſs. *Dying.*

(2.) The various ways of extracting the tinging parts of theſe ingredients; condenſing, preſerving and making them into colours, ready for uſe.

(3.) The different methods of preparing the ſubject, according to its nature, and fitting it to receive the dye.

(4.) The various ways of diſcharging the colours, once given to ſilks and ſtuffs.

The art itſelf.

11. (1.) The ways of preparing the ſeveral dye-liquors, for blacks, blues, reds, yellows, greens, &c. with the means of opening the colours.

(2.) The manner of applying the ſubject to the dye; with the particular encheireſes requiſite to the full imbibing and fixing the colour.

(3.) The method of waſhing and treating the ſubject when it comes out of the dye.

(4.) Attempts to improve the ſeveral branches of this buſineſs; as fulling, ſcowring, diſcharging, opening the *materia tinctoria*, condenſing the tinging parts, fixing the colours, and changing them ſo as to imitate the fineſt fixed colours of the *Indies*. With a particular inquiry into the methods of improving the grain-colours, and rendring them cheaper.

(5.) To conſider how far this art is applicable to the dying of leather, feathers, paper, ſhells, &c. with its farther uſes in natural hiſtory and philoſophy.

The art of converting refuſe or excrementitious animal ſubſtances to chemical uſes.

12. (1.) The methods of preparing nitre, ſal-ammoniac, volatile ſalts, &c. from theſe animal matters. *Turning refuſe animal matters to uſe.*

(2.) The ways of procuring nitre in the eaſt, and ſeveral *European* countries: with a particular inquiry whether this art may be practiſed to advantage in *England*.

(3.)

(3.) The method of making fal-ammoniac in the *Levant*; with the ways of producing the fame falt to profit in other places.

(4.) The art of making phofphorus from urine and other cheap excrementitious animal matters.

II.

Hints for the improvement of certain arts exercifed on vegetables.

The art of preparing timber.

Timber. 13. (1.) The phyfical caufe of a decay and rottennefs in timber; with the artificial means of preferving it found, ftopping the rot, and killing the worm.

(2.) An inquiry into the beft methods of careening and cafing of fhips, and preferving the timbers from the injuries of the fea.

(3.) The methods of fitting wood to endure long under ground, in watery places, or when expofed to the viciffitudes of the weather.

(4.) An attempt towards turning one fpecies of wood into another; as the making artificial cedar, *&c.* from the more common forts of timber.

(5.) The method of bending large timbers for the ufe of the fhip-wright, *&c.* with the ways of repairing the damage they may receive in the operation.

(6.) An inquiry into the beft ways of preparing timber, fo that it fhall not readily take fire; with a view to prevent conflagrations, or the firing of fhips, houfes, *&c.* and particularly to inquire whether this may not be effected by laying fome certain preparation upon the wood-work; or by an artificial coating, a degree of petrefaction, *&c.*

The art of refolving certain kinds of wood by fire; viz. *into tar, pitch, turpentine, oil of turpentine, rofin, charcoal, and pot-afh.*

Tar, &c. 14. (1.) The method of doing each of thefe to beft advantage in different places; with an inquiry how far they are practicable in certain parts of *England*, and our own plantations.

(2.) A particular inquiry into the whole affair of pot-afh; with the ways of making it clofe, hard, and ftrong, in *England* and the plantations; or equal to that of *Ruffia*.

(3.) The different kinds of pot-afh, and kelp, of different countries; whence their vicioufnefs, ftrength, and other good and bad qualities: with the beft and eafieft ways of proving their goodnefs, for the ufes of the foap-boiler, dyer, glafs-maker, *&c.*

The art of wax.

Wax. 15. (1.) The method of bleaching the common bees-wax, or turning it to white-wax; whence the art of the wax-chandler, in making the feveral forts of wax-candles, fealing-wax, and compound-wax for ftamps, *&c.* With an attempt towards leffening the price of wax in *England*; by the introduction of certain new fubftances, to anfwer the fame ends.

The

The art of bread.

16. (1.) This art confider'd in different countries, as practifed upon various mealy vegetable fubjects. *Bread.*

(2.) The common manner of making bread in *England*, compared with that of *France*, and other *European* nations.

(3.) The methods of improving the art of bread-making, by raifing nurferies of yeaft, or introducing new means of preferving it frefh and found.

(4.) This art fhewn applicable alfo to animal fubjects, with great advantage in fome cafes.

The art of ftarch and powder.

17. (1.) The common procefs for preparing ftarch, from wheat-meal, by fermentation. *Starch.*

(2.) The fame procefs applied to other mealy, and fome glutinous vegetable fubftances; as potatoes, rice, *&c.*

(3.) The method of reducing ftarch to hair-powder of different kinds; with the adulterations and abufes commonly practifed in this art.

(4.) Inquiries into fome more advantageous ufes of the ftarch-maker's liquor; and methods of fhortening the procefs.

The art of malt.

18. (1.) This art, as commonly practifed in *England*, traced from the fteeping-ciftern to the granary. *Malt.*

(2.) Some improvements made therein by other nations, particularly the *Germans*, and of late among the *Englifh*.

(3.) The methods of advancing this art ftill farther, and applying it to the malting of buck-wheat, *Virginia*-wheat, rice, and other glutinous grains; pulfe, legumens, and fome cheap feeds, or efculent roots and plants, for various purpofes.

(4.) The method of drying malt to perfection, with any kind of fewel, by means of the *balneum mariæ*; *&c.* fo as not greatly to alter its tafte and colour.

The art of brewing and fermenting.

19. (1.) The common procefs of brewing for malt-liquors, improved in its feveral parts. *Beer.*

(2.) The ufe of fome particular additions, in the bufinefs of brewing.

(3.) The art of fermenting by compreffion, recommended.

(4.) The ufe of hops improved, or fuperfeded.

(5.) *Glauber*'s method of condenfation, fhewn practicable to advantage in the bufinefs of brewing.

(6.) The beft manner of brewing for exportation, and long voyages.

(7.) The improv'd ftate of this art in *Germany* confider'd.

(8.) The methods of reducing brew'd liquors to their leaft volume, without impairing their virtues.

(9.) The fophiftications and abufes often practifed in this art.

(10.) The methods of brewing to vary with the intention of the operator.

(11.)

(11.) The application of this art to various new ſubjects.

(12.) The practical hiſtory of fermentation in its full latitude.

The art of wines.

Wine. 20. (1.) Various improvements in the common methods of preparing wines, both in *England* and in the proper wine-countries.

(2.) Several methods of making as excellent wines in *England*, or other more northern countries, as thoſe of the prime growths of *France*, *Italy*, *Greece* or *Hungary*.

(3.) Inquiries into the true methods of producing taſteleſs wines, of any aſſignable degree of ſtrength, or richneſs; and of giving them the perfect colours and flavours of any particular foreign wines.

(4.) The methods of condenſing wines, or reducing them to their utmoſt perfection; without admitting any ſuperfluous part.

(5.) The art of converting *Engliſh* cyder, and the tappings of certain trees, into tolerable wines.

(6.) The whole buſineſs of wines ſhewn practicable to great advantage in *England*; whether wines be conſidered as natural, or artificial productions.

(7.) Attempts to make extemporaneous wines; or to turn water into a vinous liquor of the nature of genuine wine.

(8.) The beſt methods of remedying the various diſeaſes of wines.

The art of vinegars.

Vinegar. 21. (1.) Shorter methods than the common of turning beer or wines into vinegar.

(2.) An attempt to ſhew ſome profitable ways of preparing vinegar; without wine, or the trouble of brewing.

(3.) An extemporaneous way of making vinegar by boiling the wine, *&c.*

(4.) The ways of recovering decayed vinegar; and making it of any degree of ſtrength.

(5.) The method of condenſing vinegar, or reducing it to its leaſt volume.

(6.) An attempt towards producing a ſolid vinegar; or obtaining the ſalt thereof.

The art of diſtillation.

Spirits. 22. (1.) Improvements of this art in its ſeveral parts; *viz.* brewing, fermenting, ſimple diſtilling, rectifying, and compounding; ſo as to make it anſwer the different intentions of the operator.

(2.) How to brew in perfection for diſtillation.

(3.) How to raiſe nurſeries of yeaſt, and to preſerve it long for the purpoſes of diſtillers.

(4.) How to work with expedition in this art; and how to greateſt advantage.

(5.) How to make a clean malt-ſpirit.

(6.) The buſineſs of proof in ſpirits particularly examined.

(7.) The way of diſtilling wine-lees to advantage.

(8.) The beſt methods of rectifying all kinds of vinous ſpirits.

(9.) The beſt form wherein to export and preſerve ſpirits.

(10.) The beſt ways of judging the goodneſs and purity of ſpirits.

(11.) Inquiries into the beſt acid, for giving a true vinoſity to vulgar rectified ſpirits.

(12.) The ways of colouring ſpirits, and fitting them for ſale.

(13.) The principal uſes of the common ſpirits extended.

(14.) The hiſtory of ſpirits, foreign and domeſtic.

(15.) The method of turning common ſpirits into brandies, or arracs, undiſtinguiſhable from the foreign.

(16.) The true method of working in compound diſtillation. This ſubject is treated at large, in our eſſay upon the buſineſs of diſtillation.

The art of ſugar making, and refining.

23. (1.) The common proceſs of making ſugar from the natural juice of the ſugar-cane, chemically conſidered. *Sugar.*

(2.) Attempts to ſhorten this proceſs.

(3.) The whole buſineſs of boiling ſugars to their proper height; the more certain ways of taking of proof, preventing of burning, and making the matter granulate to the beſt advantage.

(4.) An inquiry into a method of converting the melaſſes or treacle into tolerable ſugars.

(5.) This art applied to honey, and other vegetable juices; with a particular inquiry whether ſugar-works might not be ſet up to advantage in wine-countries, and countries productive of corn, or certain trees that yield plenty of a ſaccharine liquor by tapping.

(6.) The art of refining ſugar, into the different kinds of clay'd, lump, loaf, &c. with the methods of different countries, but particularly of *Germany*, for this purpoſe.

(7.) Some attempts towards diſcovering cheaper and more expeditious ways of refining ſugars, and bringing them, with eaſe, to a perfect whiteneſs.

(8.) To ſhorten the proceſs of making ſugar-candy; or to perform it without heat, and the cockle-room.

(9.) An attempt to introduce ſeveral new and profitable uſes of ſugars, both in *England* and the plantations.

The art of ſoap-making.

24. (1.) The common methods of making the different kinds of ſoap, in *England*, conſider'd. *Soap.*

(2.) To ſhorten the common ways of preparing the lixiviums, and the long operation of boiling.

(3.) The methods of making the hard oil-ſoaps at *Joppa*, *Venice*, *Alicant*, *Caſtile*, and *Marſeilles*; with attempts to produce as excellent in *England*.

(4.) To prevent or take off the rank ſmell of certain kinds of ſoap, and give it any agreeable ſcent and colour.

(5.) An attempt to perfect ſome extemporaneous methods of making either ſolid or liquid ſoaps.

(6.) An attempt to prepare and introduce certain medicinal ſoaps, of uncommon virtues and uſes.

(7.) The manner of making mild ſoaps for the fineſt lace and linens; and for medicinal uſes.

The art of tartar.

Tartar. 25. (1.) The methods of producing tartar from different matters.

(2.) The vulgar method of refining tartar in *Languedoc*.

(3.) An attempt to convert red tartar into white.

(4.) The beſt and moſt expeditious ways of refining or bringing it into what is vulgarly called cream of tartar; ſo as to make it perfectly tranſparent, and clear as well as white.

III.

Hints for the improvement of certain mineral arts.

26. The mineral arts may be conſider'd, as they regard ſalts, earths, or metals.

The art of making table-ſalt.

Salt. 27. (1.) The beſt manner of working ſalt from the ſea-water, and ſalt-pits, in *France* and *England*.

(2.) The uſes of the bitter liquor of the ſalt-pits, called *Bittern*.

(3.) The ways of refining ſalt, both at home and abroad.

(4.) The improvement of ſalt-making, by means of congelation, or freezing.

(5.) Some new methods of obtaining ſalt, in its greateſt purity and perfection.

The art of making copperas and vitriol.

Vitriol. 28. (1.) The proceſſes for making the common green and blue vitriols; with an enquiry into the beſt ways of ſhortening theſe proceſſes.

(2.) Attempts towards an advantageous method of converting green vitriol into blue; or the vitriol of iron into that of copper.

(3.) Some particular uſes of the raw-liquor of the pyrites, before it is boiled into copperas.

(4.) Uſes of the refuſe copperas, or ciſtern-bottoms.

The art of borax.

Borax. 29. (1.) A philoſophical and chemical inquiry into the origin, nature, and uſes of this ſalt, as found in the *Eaſt*; and thence brought into *Europe*, under the form of tincar or tincal. Whether it be a natural or factitious thing; with the manner of collecting, preſerving and packing it up. Whether it be not naturally procurable in *Europe*. Whether the *Venetians* have any ſecret relating hereto. And in what condition this Affair ſtands with the *Dutch*. Whence the imperfect knowledge of this ſubject ariſes among the natural hiſtorians, chemiſts, and literati.

(2.)

(2.) Attempts to imitate this ſalt; more particularly with a view to ſoldering, and the buſineſs of metals.

(3.) The true method of refining this ſalt, and bringing it to its utmoſt purity and beauty.

The art of burning ſtone, and earths.

30. (1.) The beſt materials of lime for the uſes of the builder; with the moſt perfect methods of burning the ſame, ſo as to make firm and durable plaiſter, *&c.* *Brick.*

(2.) The beſt manner of burning different clays into brick, and tile; for mortar, building, *&c.*

(3.) An attempt to burn brick, ſo as to make it reſemble ſtone.

(4.) The way of burning alabaſter, talc, *&c.* for plaiſter of *Paris*; and to make it of a ſtony hardneſs.

(5.) The art of enamelling, and the art of ſtaining, applied to brick-making; ſo as to make bricks of any colour at pleaſure.

(6.) The ways of burning clay-earth for manure.

The art of pottery.

31. (1.) The ſtate of this art in different countries; as it works in clay, ſtone, and the finer earths, for the forming of veſſels. *Earthen veſſels.*

(2.) Attempts in *England* and elſewhere, to imitate or exceed the *Indian* porcellane; with accounts of their failure or ſucceſs.

(3.) The whole buſineſs of glazing, conſidered and improved.

(4.) Attempts to improve upon *China* ware, by the uſe of ſome new compoſitions, or mixtures of earthy matters; with a particular account of the *Dreſden China.*

The vulgar art of metals.

32. (1.) The buſineſs of finding, judging and digging of mines; and ſeparating, purifying and working the metals, from the ore to the utenſil: with the later diſcoveries and improvements made in this ſubject. *Metals.*

(2.) An inquiry into the beſt methods of working the ſtubborn ores; with the ways of improving the buſineſs of fluxes.

(3.) The ſeveral ways of making the compound or artificial metals; as braſs, pewter, bell-metal, *&c.* The various method of ſoftening, hardening, and blanching copper; and giving it the appearance of ſilver or gold.

(4.) Improvements in the compound metals; ſo as to imitate gold and ſilver in ſeveral works, to greater exactneſs.

(5.) The methods of making iron with pit-coal, and ſoftening caſt-iron; with ſome attempts to render iron malleable without heat, or to make it work like copper.

(6.) Attempts to ſeparate ſilver from tin; and to find if any proportion of the tin be convertible into ſilver.

(7.) The chemical hiſtory of ſolders; with improvements in this uſeful branch of metallurgy.

(8.) The beſt methods of tinning iron-plates, copper-plates, *&c.*

(9.) An inquiry into the nature, phænomena and effects of *Stahl's* phlogiston, or unctuous principle, in the affair of metals.

(10.) The business of gilding and washing of metals.

(11.) An inquiry into the methods of making the red and white copper of *Japan*.

(12.) The more certain methods of detecting adulterations and abuses in metals.

The higher art of metals.

Alchemy. 33. (1.) Attempts to procure the mercuries of the several metals.

(2.) A set of new experiments to shew whether one metal is transmutable into another.

(3.) Some endeavours to fix common mercury into a metalline or ductile matter; and to soften the regulus of antimony.

(4.) The common method of turning iron into copper examin'd.

(5.) Mr. *Boyle's* method of transmuting gold into silver examin'd.

(6.) A summary view of the sublimer metallurgy in all its parts; with particular observations and improvements upon such things therein as appear solid and useful.

The art of smithery.

Smithery. 34. This art chemically considered in the hands of the goldsmith, silver-smith, copper-smith, tin-man, pewterer, plumber, and iron-smith; with some attempt to supply their respective desiderata.

The art of foundery.

Casting. 35. (1.) To find the best mixtures and methods for casting large ordnance, bells, *&c.*

(2.) Inquiries into the most direct means of making the metal run smooth, close and sound.

(3.) The common business of foundery in brass, improved.

(4.) The ways of casting iron-guns, stove-backs, *&c.* at the iron-furnace; with a view to their improvement.

The art of practical minerology.

Examining minerals. 36. (1.) Chemical methods of examining the various mineral bodies; to discover their natures and contents.

(2.) The principal uses of such bodies as cadmia, arsenic, mundic, yellow zink, *&c.*

(3.) The various metallic compositions to be made with them; and the manner wherein they affect and alter the perfect metals.

IV.

Hints for the improvement of certain mix'd chemical arts.

37. By mix'd arts we understand those which are exercised upon subjects of more than one of three classes at once; as upon animal and vegetable subjects together.

The

The art of paper, in wool, ſilk, and linen.

38. (1.) The common methods of making the different kinds of paper. *Paper.*
(2.) This buſineſs conſidered, with a view to ſhorten and improve the proceſs.

(3.) The methods of making the whiteſt paper, and giving any kind of colour thereto; with the uſual method of making that called marbled-paper; with its improvement, both at home and abroad, &c.

(4.) Some attempts to render paper more durable, and leſs apt to be gnaw'd, or torn by domeſtic animals, &c.

(5.) The ſtate of this art in *China*, *France*, *Holland* and *England*.

(6.) The ways of emboſſing and printing of paper for hangings, &c.

(7.) The application of this art to the *aſbeſtos*, ſo as to make incombuſtible paper.

(8.) An attempt towards a method of diſcharging the printers ink out of paper.

(9.) The beſt way of making filtring-paper for chemical uſes.

(10.) New kinds of paper for cartridges, hangings, &c. that ſhall not take fire.

The art of inks.

39. (1.) Ways of preparing ſolid and fluid inks, of all colours. *Inks.*
(2.) Methods of diſcharging moſt kinds of ink.

(3.) Ways of recovering the colour of decay'd ink; ſo as to render old and almoſt effaced manuſcripts legible.

(4.) The ſympathetic inks conſider'd.

(5.) The printers ink improved.

(6.) Ways of curing the imperfections of the common writing-ink, ſo as to render it undiſchargeable; preſerve it from ropineſs, mouldineſs, and being prey'd upon by time, and vermin, that would otherwiſe deſtroy the paper.

The art of japanning.

40. (1.) The ſtate of this art in *England*; with its means of improvement. *Varniſh.*

(2.) An attempt to introduce the amber-varniſh, ſo as to give a thick coat of real amber.

(3.) The japanning of *Europe* compared with that of the *Eaſt*.

The art of glaſs.

41. (1.) The common proceſſes for making the different kinds of glaſs, examin'd. *Glaſs.*

(2.) The ſtate of this art in different countries.

(3.) The late improvements in the art of glaſs, carried ſtill farther.

(4.) Attempts to prevent veins in the finer glaſs.

(5.) Attempts to diſcover ſome material for the glaſs-houſe pots, not ſubject to crack or flaw in the fire.

(6.) The moſt practicable ways of ſtopping ſuch cracks, when they happen.

(7.)

(7.) The methods of ftaining and colouring glafs.

(8.) The ways of imitating gems in glafs.

(9.) Attempts to make glafs approach the hardnefs of the diamond.

(10.) Attempts to mollify glafs, or render it in fome degree malleable.

The art of pharmacy.

Medicines. 42. (1.) The prefent ftate of chemical pharmacy confider'd.

(2.) How far it obtains, and how far it fails of obtaining the fpecific virtues of the *materia medica.*

(3.) Attempts to introduce various new and effectual methods of treatment into this art; with a view to procure the real virtues of fimples, and render them fpecific.

(4.) An attempt to regulate and afcertain the bufinefs of compofition in this art.

The art of pigments.

Pigments. 43. (1.) This art confidered, in the hands of the dry-falter, colour-man, and painter.

(2.) The beft and fhorteft methods of preparing the feveral pigments; as white-lead, red-lead, the lakes, the blues, the greens, the reds, *&c.* with the ways of grinding, mixing and fitting them for the painter's pallet, and other ufes.

(3.) Attempts to introduce feveral new kinds of artificial pigments.

The art of fire-works.

Fireworks. 44. (1.) The beft methods of preparing gunpowder, for its feveral ufes.

(2.) Attempts to make the whole parcel of gunpowder take fire inftantaneoufly in large charges.

(3.) Some attempts to improve gunpowder, and increafe its force; with the beft ways of preferving it from accidents.

(4.) The whole bufinefs of fire-works confider'd.

(5.) Some attempts to imitate the phænomena of the fun, *&c.* by fire-works.

(6.) An inquiry into the *Chinefe* method of fire-works.

The art of printing on Callico, and linen.

Staining. 45. (1.) The ufual methods of preparing the fubject, laying on the colours, or giving and fixing the ftain.

(2.) An inquiry into the durability, nature, and changes of thefe colours; and the ways of difcharging them.

(3.) The ways of imitating the fine fix'd reds and blues of *India.*

(4.) The chemical hiftory of ftains and mildews.

(5.) The chemical hiftory of madder; and its ufes in this art.

(6.) The feveral colours, at prefent ufed in callico-printing, how prepared, and improved.

(7.) An attempt to fupply the defects of this art; by ftriking certain ftains, without the affiftance of alkali and acid.

(8.) An inquiry into the ftate of callico-printing in the *Eaft-Indies*; and the chemical artifices there ufed for the purpofe.

The art of printing on paper, with metalline types.

46. (1.) The beft ways of preparing, cafting and working the mix'd metal for printers types; fo as to give the letter a full face. *Printing.*

(2.) The moft expeditious methods of cleanfing the forms.

(3.) Attempts to improve the printer's varnifh.

(4.) Certain attempts to improve the printer's ink.

47. Befides the various arts of this kind, which feem more directly chemical, there are many others capable of receiving improvement from chemiftry; and among thefe may be reckon'd painting, fculpture, ftatuary, architecture, agriculture, hufbandry, navigation, aftronomy, and all the practical arts, both of peace and war.

48. Upon a flight furvey of the prefent ftate of the chemical arts in *England*, there appears to be room for the introduction of feveral new ones; and, among others, the following.

(1.) The refining of animal fats, for curious ufes.

(2.) The making of fal-ammoniac from refufe matters.

(3.) The improved method of refining camphire.

(4.) The refining of tartar, into beautiful cryftals.

(5.) The refining of coarfe manna.

(6.) The improvement of *Epfom* falt.

(7.) The compleating of borax; or the perfect manner of refining tincal.

(8.) The boiling down malt-wort to a treacle, for diftillation, brewing, and exportation.

(9.) New art of brewing, with cheap materials.

(10.) New art of wines.

(11.) New art of vinegars.

(12.) New art of producing, and rectifying fpirits.

(13.) The perfect imitation of *French* brandies, and *Indian* arracs.

(14.) The preparing of new *Englifh* brandies, and *Englifh* arracs.

(15.) The raifing nurferies of ferments, of different kinds.

(16.) The art of recovering eager wines, and mufty drinks.

(17.) New manufacture of wine-lees.

(18.) The manufacture of white-lead, without vinegar, horfe-dung, or grinding; or without prejudice to health.

(19.) The making of *Englifh* liquorice.

(20.) The making of *Englifh* opium.

(21.) The art of teas.

(22.) New art of fnuffs.

(23.) The making of oil-foap.

(24.) The making of blue vitriol.

49.

49. The ſeveral preceding articles are not here propos'd as bare hints only, or ſuperficial glances unwarranted by experiments or obſervation; but as an intimation of ſome advantage to be rationally expected from a due proſecution of the ſubject.

SECT. III.

Of Commercial CHEMISTRY.

Commercial chemiſtry. 1. BY commercial chemiſtry is meant the application of philoſophical and technical chemiſtry, to the founding, ſupporting, and improving of trades and commerce.

Its parts. 2. In this view commercial chemiſtry will conſiſt of three principal parts; *viz.* (1.) The exerciſe of all the chemical arts in ſuch a manner as to ſupply beyond the demands of a ſingle nation; and afford a ſurplus of commodities for exportation, and foreign conſumption. (2.) The ſeveral ways of condenſing, curing, preparing, ſecuring and fitting natural and artificial productions, or commodities, for tranſportation and carriage. And (3.) The means of ſupplying the chemical neceſſaries to voyagers, and travellers, for founding, ſupporting and improving trade, traffic, and commerce in different countries.

Hints for extending the chemical arts, and rendring them commercial.

How to be extended. 3. This Subject is of too complex, and intricate a nature, to be adjuſted from bare philoſophical and chemical conſiderations: a knowledge of the different policies, laws, intereſts, and cuſtoms of nations is here required; or the joint abilities of the ſtateſman, and the merchant. Thus perhaps it might not, tho' it were practicable, be the intereſt of *England* to rival *France* in wines and brandies; *Germany*, and *Sweden* in metals; nor *Holland* in the production of corn-ſpirit, and the cheap preparation, or refinement, of certain other commodities.

4. But ſuppoſing *England* at full liberty, and the cuſtoms, duties and draw-backs in her favour; then it is a point of philoſophical and chemical conſideration, to ſhew what arts may be render'd commercial, for the benefit of our own kingdom. And among others of this kind may come the following; *viz.*

(1.) The arts of wines and brandies; from grapes of *Engliſh* growth.

(2.) The ſame arts, without grapes, to greater advantage.

(3.) The art of producing corn-ſpirit, to better advantage than the *Dutch*; and under-ſelling them at the foreign markets.

(4.) The art of producing vinegars, cheaper than in *France* or *Holland.*

(5.) The art of producing arracs, equal or ſuperior in goodneſs to thoſe of *India.*

(6.) The art of refining camphire, to greater perfection than in *Holland.*

(7.) The art of making hard oil-ſoaps, equal to the foreign.

(8.) The arts of curing ſeveral ſorts of fiſh, and fleſh, to greater advantage than in *Holland*, *Germany*, *&c.*

(9.) The art of refining borax, to greater perfection than in *Holland.*

(10.) The art of making white-lead, to greater advantage, than in *Holland.*

5. It is not neceſſary to be large in the enumeration of other chemical arts, no leſs improveable than theſe, for the purpoſes of commerce; becauſe a ſingle one, when fully advanced and extended, may often prove the principal buſineſs of a whole country; as the art of wines in *France*, *Spain*, and *Portugal*; the art of ſugar in the plantations; the art of metals in *Germany*, and *Sweden*, &c. And in this large view it is that arts come to be conſider'd under the head of commercial, as, in a leſs extenſive way, they fall under that of technical chemiſtry; to which we therefore refer.

Conſiderations on the more perfect ways of condenſing commodities, for exportation, without impairing their virtues.

6. Before goods are ſent abroad, 'tis proper they ſhould be reduced to the leaſt volume they are capable of, without injury; and put into a condition of receiving the leaſt damage from the weather, ſalt-water, and other accidents. Thus, metals are tranſported inſtead of their ores; ſugar inſtead of the ſugar-cane; dry raiſins inſtead of grapes; high ſpirits inſtead of low-wines; ſalt inſtead of ſea-water, *&c.* with care to ſecure each ſubject, that requires it, in a ſuitable fuſtage, or futail. And thus by means of commercial chemiſtry, different countries are ſupplied with pitch, tar, roſin, turpentine, brimſtone, wax, oil, tallow, tann'd-hides, wines, brandies, ſalt, ſugars, treacle, paper, lead, tin, iron, ſilver, *&c.* whereby all trade, traffic, and commerce is ſupported. *Commercial condenſation.*

Hints for the hiſtory of commercial condenſation.

7. *(1.)* The method of condenſing wines, ſo as greatly to leſſen their bulk; and at the ſame time improve their virtue and goodneſs, and render them more durable, or leſs ſubject to change or decay, either by land or ſea. *The condenſing of wines.*

(2.) The way of condenſing malt-liquors and vinegars for exportation, in the form of a rich liquid, not ſubject to ſpoil in the longeſt voyage.

(3.) The art of condenſing all kinds of ſpirits, brandies, rums, and arracs, without loſing of their natural flavours, or virtues.

(4.) The art of condenſing the juice of foreign grapes, and leaving it fit to be made into wines in countries that produce no wines of their own.

(5.) Methods of reducing the tinging parts of the more bulky dying-ſtuffs, to a kind of extract; for the uſe of dyers, *&c.*

(6.) The reduction of pot-aſh, tincal, and borax, to a leſs volume, or weight; yet retaining all their eſſential parts.

Hints for the hiſtory of commercial curation.

8. *(1.)* The beſt ways of curing animal ſubſtances; but particularly fleſh, fiſh, and animal oils or fats, for exportation, and long voyages. *Commercial curation.*

(2.) The beſt ways of curing various vegetable commodities; as fruits, woods, gums, hops, tobacco, and all animal, vegetable, and mineral drugs.

Hints for the hiſtory of commercial package.

Commercial package. 9. (1.) When goods are cured, and reduced to their ſmalleſt bulk, for exportation, the next conſideration is the manner of packing them up, and ſecuring them to the beſt advantage.

(2.) Goods are reducible to two ſpecies, *viz.* fluid and ſolid; according to the nature whereof, they require a different package: whence an inquiry into the beſt ways of ſecuring oils, wines, brandies, treacle, malt-liquors, tar, turpentine, quickſilver, *&c.*

(3.) An inquiry into the beſt methods of ſecuring ſolid, but liquifiable goods; as kelp, pot-aſh, ſugar, ſoap, nitre, vitriol, borax, alum, *&c.*

(4.) The methods of ſecuring volatile and ſtrong-ſcented ſolids; as camphire, muſk, aſa-fœtida, *&c.* ſo as to prevent their avolation, or affecting other kinds of goods.

(5.) The beſt methods of ſecuring teas, and all fine goods, that are apt to catch and retain any heterogeneous odour.

(6.) The beſt ways of preparing wrapping-cloths for dry goods; as the *Eaſt-India* wax-cloth, and tutenag-caniſters, the *Engliſh* oil-cloth, tarpawling, *&c.*

Hints for a hiſtory of the uſes of chemiſtry to travellers, or in long voyages at ſea, with a view to commerce.

Chemical apparatus for voyages. 10. (1.) The neceſſaries for long, trading voyages ſhewn; as particularly a chemical cheſt, a portable-furnace, and a ſmall apparatus, conſiſting of a ſcrew-preſs for oils; of flux-powders, quick-ſilver, and antimony, *&c.* for aſſaying of gold, ſilver, and ores.

(2.) The more certain ſigns of mines; eſpecially from the chemical examination of mineral waters, and the evaporation of mineral juices.

(3.) The more expeditious ways of aſſaying animal, vegetable, and mineral ſubſtances; to ſhew what proportion of valuable or merchantable commodities they hold: illuſtrated in oils, eſſences, mineral liquors, drugs, ores, and other mineral or metallic matters.

(4.) Heads of inquiries, to be made by travellers, into the productions of different countries, as particularly into the manner of preparing arracs, nitre, borax, porcellane, and the curing of teas in the *Eaſt*; making ſal-ammoniac in the *Levant*; vitriol in *Germany*; brandies in *France*; pot-aſh in *Ruſſia*, &c.

(5.) An account of certain chemical contrivances, capable of deceiving travellers and merchants in the condition of commodities; with the moſt expeditious ways of detecting ſuch impoſitions: as the ſophiſtication of wines, brandies, vinegars, and arracs; the debaſement of gold-ſand, gold-bars, or ingots, ſilver, copper, tin; counterfeit gems, *&c.*

(6.) The more certain, and expeditious chemical ways of diſcovering the goodneſs, or genuineneſs of moſt merchantable commodities: with the beſt methods of aſſaying pot-aſh, tincal, amber, ambergreaſe, muſk, opium, aloes, the natural balſams, bezoars, and various other kinds of drugs.

(7.)

(7.) The more ready ways of examining whether unexperienced waters be wholefome.

(8.) The beft methods of preferving fruits, flowers, and feeds in their perfection, during a long voyage.

(9.) The beft methods of obtaining and preferving frefh-water at fea.

(10). The beft and moft expeditious ways of edulcorating the fea-water, fo as to render it potable, or fit for common ufes.

(11.) The beft methods of preferving frefh provifions, at fea.

(12.) The beft pharmaceutical methods of curing certain difeafes incident to failors, and travellers, in long voyages, and in fome particular countries.

SECT. IV.

Of Oeconomical CHEMISTRY.

1. BY œconomical chemiftry, is underftood the application of philofophical, technical, and commercial chemiftry, to the particular ufes of a family. *Oeconomical chemiftry.*

2. Hence œconomical chemiftry is of great extent; as bringing into practice, tho' in a fmall way, moft of the larger works of commercial and technical chemiftry: from the latter whereof, it differs only as that does from commercial chemiftry; the firft producing to ferve a family, the fecond a fingle nation, and the third the world. *Its ufes and extents.*

3. This branch of chemiftry may be confider'd with regard to the feveral offices of a houfe; wherein, as in fo many different laboratories, 'tis ufually practifed; that is, with regard to the brew-houfe, the cellar, ftore-room, kitchen, dairy, laundry, and their refpective ftores, furniture, and apparatus.

Hints for the œconomical hiftory of fermentation, or the management of the brew-houfe and the cellar.

4. *(1.)* The beft methods of brewing with malt, for the fervice of a family. *Oeconomical fermentation.*

(2.) The method of brewing with honey, for mead, metheglin, and a liquor refembling canary.

(3.) The method of brewing with treacle, fugar, and mix'd vegetable matters.

(4.) The beft method of making cyder and perry; either fimple, or by mixture.

(5.) The method of brewing with fome particular vegetable juices, of a faccharine nature.

(6.) Certain new methods of making particular drinks.

(7.) The art of preferving yeaft, for fome months, frefh and found, for various ufes.

(8.) The whole bufinefs of making perfect, found, and wholefome wines of *Englifh* grapes.

(9.) The beſt ways of imitating all the foreign wines, without either grapes, or raiſins.

(10.) The perfect imitation of *Tokay* wine.

(11.) The art of made-wines, with raiſins, or without, to great perfection.

(12.) Some methods of curing foul and ropy wines, and recovering eager drinks.

(13.) The beſt ways of defending a vault or cellar from froſt; and of reſtoring wines or drinks that have been frozen.

(14.) The methods of preſerving the caſks and brewing-veſſels, in their greateſt purity and perfection: with certain ways of recovering muſty veſſels.

(15.) The beſt method of erecting a brew-houſe; ſo as greatly to leſſen the labour and expence uſually attending the making of drinks.

(16.) The art of vinegar and verjuice; from malt, raiſins, wines, cyder, crabs, *&c.* with the beſt methods of making them durable, and preſerving them at all times fit for uſe.

Hints for the hiſtory of the ſtillatory, and the ſtore-room.

The family ſtillatory and ſtore-room.

5. (1.) The perfect ways of making the moſt uſeful ſimple-waters.

(2.) The beſt manner of diſtilling ſpirits from the grounds of beer, ale, or wine-lees, for the ſervice of the lamp, or the making of compound waters.

(3.) A ſet of the moſt uſeful cordial waters, for the ſervice of a family; made either by diſtillation or infuſion.

(4.) Certain eaſy and cheap ways of imitating *French* brandy, and *Indian* arrac, for family-uſes.

(5.) The kind of ſtill moſt proper for œconomical purpoſes; with the method of ſetting and working it to advantage; eſpecially in large families, and gentlemens country-ſeats.

(6.) The beſt methods of drying and preſerving flowers, fruits, herbs, roots, and ſeeds, for family-uſes.

(7.) The ways of preſerving foreign fruits, as oranges, citrons, *&c.* all the year.

(8.) The art of conſerving certain vegetable productions, in vinegar, or compound pickles.

(9.) The art of conſerving fruits, flowers and vegetable juices with ſugar; for the table, and certain medicinal uſes.

(10.) The art of conſerving certain animal ſubſtances with ſalts, ſugar, and acid fumes, or ſmoke, for the table.

(11.) The beſt methods of preſerving nuts, peas, legumens, *&c.* ſo to eat as if freſh gather'd.

Hints for a hiſtory of culinary arts.

Culinary arts.

6. (1.) To determine the beſt fewel for kitchen uſe; and a method for rendring it cheap, and inoffenſive.

(2.)

(2.) The moſt expeditious and agreeable methods of lighting a fire, or warming a room.

(3.) The beſt methods of preventing the inconveniences ariſing from ſmoke, ſoot, and effluvia in a kitchen.

(4.) The art of edulcorating the refuſe fat of a kitchen, for lamps or other œconomical uſes.

(5.) The manner of introducing the *Balneum Mariæ*, and *Papin*'s digeſtor, into the kitchen, with advantage.

(6.) The beſt methods of preſerving all the metalline furniture of a kitchen, from ruſt and tarniſh.

(7.) The method of expreſſing ſallad-oils from various ſeeds; as particularly from the ſeed of muſtard, *&c.*

(8.) The method of making the fineſt and keeneſt ſalt for the table; with the ways of rendring it medicinal to certain purpoſes.

Hints for the chemical hiſtory of the dairy.

7. (1.) The chemical hiſtory of milk, and its different parts. *Arts of the dairy.*

(2.) Methods of procuring the largeſt yield of dairy productions.

(3.) The chemical hiſtory of rennet, and certain vegetable acids, in the making of cheeſe and butter.

(4.) The proper application of cold, heat, reſt, and agitation in the buſineſs of the dairy.

(5.) To determine the beſt kind of veſſels and utenſils for the dairy.

(6.) Ways of flavouring and colouring theſe productions to any particular taſte or fancy.

Hints for the chemical hiſtory of the laundry.

8. (1.) The beſt family methods of making ſoaps, for different kinds of linen and laces, *&c.* *Arts of the laundry.*

(2.) The beſt family ways of preparing the fineſt blues and ſtarch.

(3.) The beſt methods of taking ſpots, ſtains, iron-moulds, mil-dew, *&c.* out of linens and laces.

(4.) The art of bleaching, or whitening of linen.

(5.) The method of ſoftening hard waters; or fitting them for the uſes of the laundry, dairy, and the kitchen.

Hints for the chemical hiſtory of certain pleaſurable, œconomical matters.

9. (1.) An account of ſeveral curious and uſeful œconomical experiments. *Various family matters.*

(2.) To preſerve paintings, and all kinds of furniture within doors.

(3.) To preſerve wood-work, expoſed to the wet and weather.

(4.) The hiſtory of manures; and the beſt ways of preparing grain for the ground.

(5.) To render potable liquors cool and pleaſant in the ſummer, or in hot countries.

(6.) To find pleaſant and wholeſome ſubſtitutes for teas, *&c.* in *England.*

(7.) The hiſtory of the hot-houſe; with new contrivances for producing the pine-apple, coffee, and various foreign fruits.

(8.) The ways of procuring grateful odours, and re-vivifying the air in rooms, or large aſſemblies.

(9.) The ways of exhibiting curious chemical phænomena at public entertainments, in the way of illuminations, *&c.*

10. Thus we have lightly touch'd ſome principal heads, under which chemiſtry, or artificial philoſophy, may be conſider'd, with a view to its farther advancement. The form wherein they are ſpoke to, being that of hints, ſhews them intended for perſons already acquainted with the art: as hints are more ſuited, and often prove more acceptable, to the intelligent in any art, than thoſe full explanations, and deductions, which are grateful chiefly to the leſs knowing; who may be better gratify'd by exemplifying and illuſtrating the particulars here intimated. For the preſent, it is hoped, that any one may hence form ſome tolerable notion of chemiſtry; and become ſenſible of its utility.

E S S A Y II.

An ESSAY to introduce a *PORTABLE LABORATORY:*

By means whereof all the

CHEMICAL OPERATIONS

Are commodiouſly perform'd,

For the purpoſes of philoſophy, medicine, metallurgy, and a family.

With SCULPTURES.

S E C T. I.

P R E L I M I N A R I E S.

1. THE intention of this eſſay is to facilitate, and promote, the practice of chemiſtry, by delineating a commodious laboratory; with ſome familiar directions for its uſe and application. *The deſign.*

2. But as the uſes of the laboratory cannot be underſtood without ſome previous knowledge of the art intended to be practiſed with it; we ſhall here, by way of preliminaries, give a ſhort view of chemiſtry, and point out the general manner of exerciſing it to advantage.

3. Chemiſtry is of a very extenſive nature; ſo as to aſſiſt all the other arts and ſciences: whence it may be conceived as an effective or artificial kind of philoſophy, that greatly contributes to ſet on foot and promote the active buſineſs of the world. *Nature of chemiſtry.*

4. The art indeed has hitherto been little conſider'd in this light; but 'tis time to advance it beyond an infant ſtate, and introduce it farther into human affairs.

5. The works of *Lully*, *Valentine*, *Hollandus*, *Paracelſus*, *Helmont*, *Glauber*, and the generality even of the more eminent chemiſts, do not ſhew us the true nature and genius of chemiſtry; or the direct manner of applying it to the improvement of uſeful knowledge, arts, trades, and the buſineſs of men. Thoſe authors either had not the neceſſary tempers or talents for the purpoſe; ſome of them wanted generoſity and frankneſs, others a due compaſs of knowledge, others a clear and intelligible way of delivering themſelves; and moſt of them wanted a tincture of the true philoſophy and geometrical reaſoning: ſo that, in general, they have amuſed, perplexed and puzzled themſelves, as well as their readers; and thus render'd a plain and rational art diſagreeably intricate and forbidding.

6.

Its use to philosophy. 6. But the happy philosophical temper and talents of Mr. *Boyle*, have clear'd us of this embarassment; and shewn how chemistry may be familiarly practised to advantage: his diffusive knowledge, and sober reason, have settled the art upon its true foundation; and directed the application of it to the noblest uses. He has shewn us the method of introducing sound philosophy into the laboratory; and there applying it to business, the promotion of arts and every kind of useful science. And perhaps there is no better method than this, discoverable by human means, for the advancement of philosophy itself, and the practical inventions of men.

7. Thus, the common philosophy of our times is often explain'd, illustrated, confirmed, improved, and in some cases shewn to be insufficient, by the proper use and application of chemistry; whose peculiar province it is to separate, dissolve and compose bodies by art, change their internal texture, and give them new, sensible properties, forms, and appearances. For example, it can readily change the colours, tastes and odours of various concretes; render fix'd bodies volatile, and volatile bodies fix'd; turn fluids into solids, and solids into fluids; corrosive bodies into neutrals, and neutral into corrosive bodies; with numerous instances of the like nature; and all this by means of certain operations, the causes whereof are in the hands of the artist: whence the furnace becomes an admirable engine for philosophical inquiries. And accordingly, the uses which Mr. *Boyle*, M. *Homberg*, Dr. *Stahl*, and some few others have made of it, open to us a new scene of things; and shew the system of the world itself to be a kind of laboratory, where infinite operations are at once carried on without confusion.

8. And whoever desires to succeed in philosophical chemistry, might do well to imitate the authors just now mentioned; both in the business of experimenting, and reasoning upon it; which they pursue in a calm, geometrical manner, from *data* to *quæsita*; having previously form'd to themselves a kind of chemical algebra, whereby they soon find whether a problem be solvable, and in what manner its solution should be attempted. The excellence of chemistry lies not in hurry and multiplicity of experiments; but in a sedate and orderly performance of operations, with particular views; and coming at the end by the shortest means; all along observing the phænomena, so as to give a satisfactory cause of the effect; and shew how the discovery may turn to advantage.

9. Chemistry, practised in this discreet manner, seems capable of answering any expectation that can be rationally entertain'd of it: but will constantly perform less, in proportion as it recedes from so fundamental a rule. This may appear by comparing together any number of chemical authors; who are always found to succeed best in the improvement of the art, as they had a greater compass of knowledge, and a cool philosophical head. For example, let *Boyle*, *Homberg*, and *Hoffman*, be compared with *Becher*, *Kunckel* and *Glauber*, and the difference will presently appear, together with its cause.

10. The chemical analysis of so simple a thing as nitre, led Mr. *Boyle* into the mechanical explanation of fluidity and firmness, volatility and fixedness, corrosiveness and corrosibility, tastes and odours, and the nature of forms and qualities in bodies; all which he has given with that perspicuity and elegance,

elegance, as cannot but recommend chemiſtry to thoſe who are concern'd for the improvement of philoſophy. But *Becher*, with great talents and a warmer head, has run thro' many branches of philoſophical chemiſtry, in a laudable indeed, but leſs diſtinct and perſpicuous manner.

11. By means of the burning lens, M. *Homberg* has ſhewn, that gold and ſilver are as volatile at the fire of the ſun, as the other metals are in our common furnaces; and adds much light to the art, by ſhewing how this new furnace may pave the way to a new philoſophy; as the microſcope and the air-pump have done in their turns (*a*): whilſt *Kunckel* has improved and enriched *Neri*'s art of glaſs, with ſeveral new diſcoveries that required leſs genius, and much ſlenderer abilities (*b*).

12. Dr. *Hoffman* has given us a collection of ſolid and uſeful obſervations, founded upon large experience, in ſeveral parts of common and philoſophical chemiſtry: but *Glauber*, an indigeſted heap, or rhapſody of improvements, many of them hypothetical, or built upon ſlight foundations (*c*).

13. But for ſolidity of judgement, and true attachment to obſervation, experiment, and geometrical reaſoning, in the ſublimer chemiſtry, Dr. *Stahl*, at preſent ſeems without competitor (*d*).

14. And as chemiſtry is thus ſerviceable to the purpoſes of philoſophy, *Its uſe to arts;* it muſt neceſſarily be as ſerviceable to arts; which are nothing but philoſophy reduced to practice, for ſupplying the neceſſities and conveniences of mankind.

15. That the rational art of medicine has an entire dependance upon che- *In medicine,* miſtry, is ſhewn by that great profeſſor of both, the learned *Boerhaave*, in his elements of the art; and is farther confirm'd by Dr. *Hoffman* (*e*). The natural ſtate of a living body, or what paſſes therein, cannot be known without its aſſiſtance. The digeſtion of the aliment; its converſion into chyle, milk, blood, and lymph; the generation and office of the bile; the origin of ſalts and oils in the blood; the great tendency of all the parts of the body to putrefaction; with numerous other phænomena and effects, require chemical explanations, before they can be ſatisfactorily underſtood. Nor are diſtempers to be known, and rationally cured, without the ſame aſſiſtance; as might be ſhewn in all inſtances, to the great advantage of phyſic.

16. Pharmacy is capable of receiving great improvements from chemiſtry; *In pharmacy.* tho' indeed this branch of medicine wants a reviſal, to ſhew how far the virtues of ſimples may be extracted for medicinal uſe, and how far the ſimples had better be given in their crude or natural ſtate. This however is certain, that many of them may have their eſſential and more efficacious parts ſeparated from the noxious and leſs uſeful, by means of chemiſtry; and thus be reduced to a commodious form for practice. In particular, a noble extract may be chemically prepared of the bark; ſo as to contain the full virtues of the concrete, without its woody part; which perhaps is ſome-

(*a*) See *Memoir de l'Academ. An.* 1702.
(*b*) *Obſervation. phyſico-chem.*
(*c*) *Glauber. Opera univerſa.*
(*d*) *Opuſc. chemico-phyſico medic. Stahlii, &c.*
(*e*) *Oſervat. phyſico-chem. in præfat.*

times the cauſe of obſtructions, and other diſorders charged upon the uſe of this remedy.

The mechanic arts. 17. As for the mechanic arts, the greateſt part of them depend almoſt totally upon chemiſtry; which either furniſhes them with tools and utenſils, ſubjects or the proceſſes themſelves. Thus all metals are the genuine productions of chemiſtry; whence tools and utenſils for all kinds of buſineſs are made. The art of glaſs is a mere chemical art, both in its ſubjects and proceſs. Various pigments are produced by chemiſtry for the uſe of the painter; and various colours for the uſe of the dyer. Salt, alum, ſoap, vitriol, ſugar, lime, brick, plaiſter, wines, brandies, and moſt of the ſtaple commodities of *Europe*, are of the ſame origin.

18. Thus, if we ſingle out any particular arts, we ſhall generally find that their riſe and improvements were owing to ſome chemical diſcovery, or application. To inſtance in the art of ſugar; had it not been for a chemical expedient, to make the boiled juice of the ſugar-cane grain, and bring it to a dry form, we muſt have been contented to have uſed a rob, or a kind of treacle, inſtead of ſugar; as it is ſaid they do in ſome parts of the *Eaſt* to this day, for want of the art of graining. And it has been found, not only in *England* but alſo in *Germany* and *France*, that the greateſt improvements in the art of refining ſugar, have been made by ſuch as were directed and influenced by ſome previous chemical knowledge.

In trades, and commerce. 19. Nor is chemiſtry leſs uſeful in the way of trade and commerce; as it teaches the beſt methods of packing and ſecuring goods of all kinds; reducing them to their leaſt dimenſions; and preſerving them from the accidents of the weather, the ſea, and the like. Thus, for inſtance, it ſhews the way of reducing all ores to their metals, refuſe-wood to pot-aſh, ſpices to their eſſential oils, brandies to alcohol; the method of condenſing wines, or bringing all their eſſential parts into a fourth of the whole, *&c.* At the ſame time, this art directs the package, fuſtage or futail, proper for every commodity, from previouſly knowing what bodies are diſſolvable, and what undiſſolvable by others. Thus, to give an obvious inſtance, as treacle is very ſubject to waſte, on account of the property it has of penetrating and diſſolving the reſinous ſubſtance of the caſk, this cannot be eſteem'd its beſt kind of futail; whence we are directed to look out for another.

Oeconomical chemiſtry. 20. And laſtly, for the ſervice of a family, nothing ſeems better fitted than chemiſtry; as it directs and teaches all the ways of making potable liquors, preſerving meats, diſtilling waters, waſhing, cleanſing, varniſhing, and preſerving goods of all ſorts; and enters at once the whole buſineſs of the kitchen, the laundry, the ſtore-room, the dairy, the granary, and the cellar; as has been ſufficiently intimated in the preceding general eſſay.

21. An art of ſuch extenſive benefit might bear to be warmly recommended, eſpecially ſince the generality ſeem little appriz'd of the nature and uſes thereof; but as in all the parts of chemiſtry, a ſedate and ſober conduct is preferable to a warm and vigorous one, we ſhall leave the reader to his own reflections upon the farther uſefulneſs of this art, and proceed to offer a few general directions for practiſing it with advantage.

22.

22. Thofe who have but a flender notion of chemiftry are apt to fancy it fomewhat myfterious, or at leaft more difficult to acquire than many other practical fciences; but a little farther acquaintance therewith will fhew it to be as eafy as practical geometry, or the common experimental philofophy; and obtainable by a moderate application. Nay, the great facility wherewith it may be learn'd hath occafion'd many writers defignedly to difguife, perplex, and render it lefs intelligible; that only the worthy, as they call them, that is, thofe who did not want their affiftance, might be benefited by it: as if all mankind had not a common right to fo ufeful a branch of knowledge! *The beft way of practifing chemiftry.*

23. 'Tis true, chemiftry, like other arts, muft be conducted by certain rules, and cannot be conquer'd at once; or to fay truth, is fcarce to be fully mafter'd by human abilities: the ufes and applications of it being almoft endlefs, or its nature inexhauftible. Yet, the common qualifications of men, without any deep or intricate ftudies, are fufficient to carry us through an inftructive and profitable courfe of it; tho' we fhould never attempt the mercuries of metals, malleable glafs, or the philofophical tincture.

24. And fuch a courfe as this, any man may proceed in; either by forming rules to himfelf, or following thofe prefcribed him by others. For, as the art is practical, and not capable of being carried on under wrong management; the operator prefently gains light from his own errors, or inftructs himfelf by his mifcarriages. And this method, when difcreetly purfued, is the beft and perhaps the only effectual one of learning the art: as it fixes and inculcates things on the mind, better than verbal inftruction, or bare ocular infpection; and renders a man intelligent and practically knowing in what he is about; at the fame time that it procures him a talent and habit of working: which no words, defcriptions, or examples could of themfelves poffibly do. And accordingly, the beft chemifts have been form'd, and the greateft improvements made in the art, by fuch kind of procedure. All that direction and inftruction can do in this matter, is only to give the firft motion to the wheel; which muft afterwards be turn'd by the hand of the operator. Chemiftry therefore cannot be a very difficult art, which thus teaches itfelf, and breeds its own mafters.

25. The danger indeed attending it is greater than the difficulty; and may regard the perfon, the underftanding, or the fortune of the operator. When a chemift treats certain bodies, whofe properties he is unacquainted withal, or commits a miftake in an operation, the fuccefs whereof has never been tried, he may fometimes run the rifk of breaking his glaffes, and being offended with noxious fumes. But accidents of this kind are rare; nor is any man obliged to try dangerous experiments, or to fearch after fuch deftructive or pernicious things as gunpowder and poifons. And in cafe any uncertain operation were to be gone upon, a little common prudence will provide againft contingencies; fo that the burfting of glaffes, or the unexpected eruption of fumes, fhall occafion no farther mifchief. And as for the general operations of chemiftry, the accidents to which any one of them is liable are exprefly defcribed and provided againft by all good authors. So that upon the whole, chemiftry is not more dangerous to the *To avoid the dangers attending it.*

perſon of the operator than many other arts; as particularly the art of mining, fire-works, caſting, building, navigation, air-pump experiments, &c. all which require to be practiſed with prudence and diſcretion.

26. The ſtudy of chemiſtry is alſo ſuppoſed to give a wrong turn to the mind; and ſet the brain at work upon impracticable ſchemes and projects: and in truth, there have been many wild chemical projectors. But this objection does not perhaps lie more againſt chemiſtry, than mathematics, divinity, and ſome other noble and rational ſtudies, which have likewiſe made the head giddy: ſo that the fault is rather in the men than the ſtudy. Whence a hot or crazy brain ſhould never be directed to chemiſtry; which of all things requires ſolidity; and is ever practiſed to beſt advantage, the more of plain natural ſenſe and ſound philoſophy is employ'd in it. Nor do the ravings and reveries of ſome ſanguine chemiſts about their elixir reflect upon the art, any more than many other dreams about the perpetual motion do upon the uſeful doctrine of mechanics.

27. But tho' the head may remain ſound, there are ſtill other inconveniences into which generous tempers, and public ſpirits are eaſily betray'd, upon making a little acquiſition in chemiſtry. When a few proceſſes have opened the mind, and given a proſpect of a great and general good to be procured by them, 'tis almoſt natural for mankind to form thoughts of extending the benefit, and reducing experiments to works. The world is ſo much obliged to this enthuſiaſtic kind of ſpirit, that perhaps it ought not to be curb'd, otherwiſe than by the difficulties and diſcouragements it naturally meets with in the execution of large deſigns. 'Tis often an eaſy matter in chemiſtry, from ſingle experiments to form ſchemes of gainful buſineſs; but it often requires thought, ſkill, and more than ordinary abilities to erect a promiſing operation into a profitable trade. Nor does the great obſtacle to ſuch an advancement uſually reſt in the art of chemiſtry; but more immediately in the civil and moral circumſtances of men: which are much more difficult to be ſeen into and directed than a chemical proceſs; eſpecially by thoſe who know but little of the turns, the tempers and paſſions of mankind. And indeed a large ſhare of ſagacity and caution is requiſite to prevent miſchievous effects upon a man's private fortune, from the imprudent exerciſe, or raſh application of chemiſtry; the danger in this caſe being ſeldom ſeen till 'tis felt. And againſt this evil, an extenſive knowledge, ſagacity, good ſenſe, and a diſpaſſionate view of things, are the only preſervatives.

A habit of experimenting to be acquired.

28. The buſineſs of experimenting in chemiſtry, or conducting the various proceſſes thereof to advantage, is an eaſy taſk, compared with the former; as depending entirely upon the acquiſition of a habit for this kind of manual operation: which is the common caſe of artizans or handycraftſmen, who are not born to adroitneſs and dexterity of the hand; but form it by time and application. A young operator muſt not expect to go through chemical proceſſes in the ſame perfection as a veteran; who might himſelf be no leſs foiled at a new operation. It would perhaps exceed the ſkill of a good chemiſt to caſt a piece of ordnance, or make a ſword-blade; tho' theſe are operations not very foreign to his ordinary employment.

employment. But a beginning muft be made; and perfection will come by degrees. In cafe of any failure, the caufe fhould be diligently inquired into; and the remedy found and apply'd. Thus for example, fuppofe a young chemift, attempting to make the common pocket-foop, fhould prepare a fine folution of animal flefh, and proceed to boil it, in a common veffel, over a common fire, to its due confiftence; he would find, before the operation was ended, that contrary to expectation, his foop turn'd black, naufeous and empyreumatic. Upon inquiring into the caufe hereof, he will difcover that his fire was too ftrong, or applied too near his matter, fo as to fcorch or burn it like a coal. This may put him upon applying the fire to another parcel of the fubject, thro' a certain medium, which will not allow it to have the fame effect: and thus he is directed to the *Balneum Mariæ*; where the thing will fucceed to his wifh. And the like method of reafoning, cafting about, and inventing, fhould be ufed in all fuch failures; whereby, at length, the beft ways of operating will be found, and the habit of preparing commodities in their utmoft perfection procured.

29. In general, chemical operations require a length of time, and a good deal of patience; to which the chemift muft, by all means, inure himfelf. To haften an operation in many cafes is to deftroy the end propofed to be anfwer'd by it. Thus in the rectification of brandies, our ordinary diftillers fometimes make their goods, as they call them, worfe than the malt-fpirit they pretend to rectify; merely thro' hafte and inadvertence.

30. Upon the whole, the practice of chemiftry requires nothing more than common care, conduct, and good fenfe, to direct each procefs fuitably to the nature of the fubject, and the intention of the operator.

SECT. II.

Description of the Furnace, its apparatus and fubjects of operation.

1. A Principal obftacle to the general exercife of chemiftry, being the difficulty of procuring proper furnaces, veffels, utenfils and materials for the purpofe; a portable laboratory, ready fitted for bufinefs, is here delineated. *Defign of the laboratory.*

2. The contrivance is fuch, that not only courfes of chemical experiments and operations may be perform'd by its means; but commodities be prepared, in a fufficient quantity to fupply the demands of a family and friends.

3. A thing of this kind was firft attempted by that excellent chemift *Johan. Joach. Becher*; to whofe labours we with pleafure acknowledge ourfelves indebted.

4. The laboratory confifts of three parts; *viz.* a furnace, an apparatus, and a *materia chemica.* *Its parts.*

The furnace. 5. The furnace is general, or fitted to perform every operation of chemistry, for private use; or even a little circle of business. It has four principal parts, which we call by the names of the cover, the ring, the body, and the foot; all of them distinguishable at sight *.

6. The general office and use of the cover is to check, suppress and throw back the heat and flame, or prevent the fewel from spending itself too fast; as it otherwise would do, with little effect in many operations. For the action of fire being not momentary, but successive, the more it is kept in, and directed upon the subject, the greater its effect, or the more thriftily employ'd. In order to increase the draught, and squeeze the air more forcibly thro' the body of the fewel, there is a moveable chimney †, that may occasionally be fix'd to the orifice, left for that and other purposes, in the top of this cover ||.

7. The ring is the seat of numerous operations; the subject to be acted upon by the fire being frequently lodged therein: and in other cases it helps to enlarge the furnace; and render it capable of operations which it could not otherwise perform *.

8. The body serves to contain the fewel, and is the common seat of the fire. In many cases of fusion, as in running metals from their ore, it performs, at the same time, the office of a crucible; and contains the subject, mix'd along with the fewel, after the manner practised in the smelting-houses †.

9. To this body belong three several grates ||, that may be placed at different heights therein, according to the nature of the operation, and the distance required between the subject and the fire.

10. And lastly, the foot, whereof are two kinds, is not only of use in supporting the other parts; but also in receiving the ashes of the fewel, and the melted matters, that by the fire are made to flow, and run down into it: and thus performing the office of a receiver, 'tis of singular use in collecting and preserving substances that might otherwise be spilt or lost *.

Its appurtenances. 11. The more immediate appurtenances of this furnace are fewel and bellows. The fewel may be charcoal; or, as there is a contrivance for a vent or flew in the body of the furnace, common sea-coal may be employ'd, and the smoke directed up the chimney of the room, where the furnace is to stand. Its structure also is well fitted for a lamp; which in many cases, as particularly some curious digestions and calcinations, is highly convenient. And by this means also, may the operations which would otherwise require the athanor, or a long continued uniform heat, be elegantly performed.

Its states. 12. It would be tedious to shew how all the numerous operations of chemistry are performable by means of this furnace; it may suffice, at present, to consider the general states or conditions into which the instrument may be put for the principal of them: whence its usefulness will appear to be uncommonly extensive.

For fusion. 13. The simplest state of this furnace is a combination of two parts; the body and the foot; which thus fit it for fusion, by the naked fire; where the matter to be melted is mix'd among the fewel, as in running the ores of lead,

* *See plate* I. II.

† *See plate* I. V. VII.

|| *See plate* I. II. V. VII.

* *See plate* I. II. IV. VIII.

† *See plate* I. II. III. &c.

|| *See plate* II, &c.

* *See plate* I. II. III.

lead, tin, or iron, for inftance: which may thus, in the quantity of many pounds, be clearly feparated from their drofs, and purged for ufe, as exactly as at the mine-works, or fmelting-huts; either with the affiftance of bellows, or without, as the nature of the ore requires *. *See plate III.

14. By barely placing the middle grate in the body, or trunk, the inftrument becomes a melting furnace for a crucible; wherein all the operations that require a fire of fufion, animated either by the air or bellows, are performable, with fuch advantages as cannot be had in the common wind or blaft furnaces, ufually employ'd for this purpofe.

15. When only the body of the furnace, with its middle grate, is fet *Digeftion, diftillation, &c.* upon the foot, it anfwers all the ends of the common fhop-furnace of the apothecary; for decoction, infpiffation, extraction, *&c.* and the purpofes of a naked fire, for certain diftillations, fublimations and the like, which require fo ftrong a heat. It may, moreover, be readily converted into a *Balneum Mariæ*, an afh-heat, a fand-heat, or a ftill ftronger for digeftion, diftillation, and fublimation, by barely fetting upon it a pan of water, afhes, fand, or iron filings †. And thus, feveral operations, requiring the fame kind of heat may be commodioufly carried on at the fame time. † See plate V. VII.

16. If, inftead of a common pan, the ring, furnifh'd with its fet of pots, be fet upon the body, with its grate, you have a furnace fitted for diftillation in *capella vacua*, as it is called; where the retorts are contain'd in the cavity of the pots, and lock'd down therein, without any vifible medium between. By which means many operations may be perform'd, in the diftillation and feparation of bodies, that could not be work'd upon to fo much advantage in any other method. And thus, in particular, may the rectification of the ftrongeft mineral acids be expeditioufly perform'd, and with little expence ‖. ‖ See plate VII.

17. An iron pan, placed in the room of the ring, juft mention'd, makes a calcining furnace; where ores may be roafted; or antimony, lead and other metalline matters commodioufly calcined or reduced to afhes *. *Calcination.* * See plate V.

18. The loweft grate being ufed, either a cold ftill or a hot one, as it is call'd, may be put into the body, and work'd as in the common manner; with its proper head and refrigeratory. And thus may cordial waters be readily made, fpirits rectified, effential oils diftilled, *&c* †. † See plate VI.

19. The application of the cover to the hollow ring, and fometimes to the body without the ring, makes a proper reverberatory furnace; for *Reverberation, &c.* cæmentation, cupellation, the affaying of ores, and diftilling by a fire of fuppreffion, as it is call'd; that is, where fire is placed above as well as below the veffel ‖. ‖ See plate IV.

20. A furnace of this nature has numerous advantages, not only over the *Advantages of the furnace.* common chemical furnaces in ufe, but even over thofe of the moft celebrated ftructure and contrivance; whether of *Glauber*, *Vigani*, or other eminent chemifts and mechanics; as ufually anfwering particular ends, as well as general ones, better than other furnaces made for one fole end. Thus it is bet- *Its numerous ufes.* ter fitted for the various ufes of *Glauber*'s philofophical furnaces, and the higher operations of metallurgical chemiftry, than thofe invented by *Glauber* for thefe very purpofes. For example, to obtain a pure fpirit of falt in plenty,

Glauber

Glauber orders the falt to be thrown upon the fire; and has contrivances to catch the rifing vapour: but this is a tedious way, and turns to very little account, in practice. Nor is the matter much improved by quenching the coals in a brine of fea-falt, and burning them for their fume: but all that can be expected in this affair may be had commodioufly from the prefent furnace; where the fire being animated with bellows, caufes the fewel to burn free and yield the fpirit much quicker; whilft the fewel is thrown in at the door of the furnace, without any trouble or difturbance to the operation: and thus the fpirit is obtain'd as pure as this procefs will afford it *. And the fame is to be underftood of the metalline fublimations, incerations, cæmentations, &c. of *Geber*, *Hollandus*, and thofe vulgarly call'd the adepts.

* *See plate* VIII.

21. But there are, befides thefe, a great number of ftill more curious, and philofophical experiments, that either cannot at all, or not fo juftly be perform'd in a furnace of a different ftructure; or with fo great difpatch and other conveniencies: as will be manifeft upon a proper ufe and thorough acquaintance with the inftrument.

22. In the mean time, it may be obferved, that this furnace is fitted for enamelling, the making of paftes, ftaining of glafs, the preparing of artificial gems, and performing abundance of other mechanical and philofophical experiments. It is alfo of fuch a nature, that any artizan, who requires the ufe of fire, may employ it in his bufinefs; as others may for the offices of a kitchen, and the common occafions of a ftove; as for warming a ftudy in cold weather, heating a vault, or the making ftove-rooms, as in *Germany* and *Holland*.

23. And befides thofe already mention'd, there are many other particular applications of the feveral parts of the furnace, which are left to be difcovered occafionally by fuch as fhall ufe it. Thus, for example, if any one fhould defire a furnace to diftil *per defcenfum*, as it is called; the cover of this furnace affords an opportunity for that purpofe; being barely inverted into the foot, as may be feen in the figure †.

† *See plate* VIII.

The furnace how to be made, and lined.

24. The outer cafe of this furnace is beft made of plated iron, form'd in feparate pieces, of the figures expreffed in the plates ‖; and of fuch a fize as the operator fhall choofe; obferving the fame proportion betwixt the parts as the fculptures exhibit. The inner fides of all the parts are to be lined, the thicknefs of an inch, at leaft, with a proper luting, carefully laid on, and gently dried; remembring to fill up the cracks, if any happen in the drying, with more of the fame luting. The following is a proper luting for the purpofe. Take a bufhel of *Windfor*-loam, four quarts of brick-duft, two quarts of powder'd green glafs, two quarts of iron-filings, four handfuls of cow-hair, and eight hand-fuls of horfe-dung: beat them all well together, with a fufficient quantity of bullock's-blood, fo as to make an uniform pafte thereof.

‖ *See plate* I. II.

The apparatus of the laboratory.

25. The apparatus of a laboratory fhould be fo fuited to the performance of all chemical operations, as that nothing, which is not readily procurable, may be wanting when it comes to be required in bufinefs. The following is calculated for the general ufes of the portable furnace; and will ferve in all ordinary cafes, or common courfes of chemical experiments. But for extraordinary

dinary purpofes it muft be farther improved or enlarged at difcretion, according to the particular exigencies and views of the operator.

26. All the chemical apparatus may be divided into remote and immediate; or fuch as is preparatory to the operations, and fuch as is actually employ'd therein. The remote apparatus of our portable furnace confifts of feveral particulars. And firft, as every chemical operation is to be perform'd in an exact, or geometrical, manner; good fcales and weights are of abfolute neceffity, for determining the quantity of the fubject employ'd; *Scales.* weight being the true index of the quantity of matter in bodies. But in common cafes, or where water, and other liquors of nearly the fame fpecific *Meafures.* gravity with that, are employ'd, it fhortens the work confiderably to go by meafure; which, in water nearly correfponds to weight: a pint of common water weighing a pound. Hence a fet of meafures are very commodious in chemical operations. But they muft be ufed with difcretion; and never be trufted in curious cafes, or where the utmoft exactnefs is required. A pint of quickfilver weighs about fourteen pounds; and a pint of fpirit of wine falls fhort of a pound.

27. Again, as many folid fubftances require to be reduced into fmall parts, *Mortars.* before they can become proper fubjects of chemical operations, there will be a neceffity for mortars, fieves, rafps, files, hammers, fheers, and forceps.

28. Next to thefe come the inftruments ufed in the management of the *Shovels,* fire; fuch as fhovels, hooks, tongs and blow-pipes. And for charging the *Tongs, &c.* veffels with the fubject-matters of the operations, we require hollow-fhells, horns, tin-plates, brufhes, hares-feet, fpoons, fpatulas, and rounds to fet certain glaffes on: and for emptying the productions, hooked-tongs, cones, ingots, bafons, funnels, and ftore-glaffes, furnifh'd with common corks, *Funnels and* wax-corks, or glafs-ftopples, to be tied down with bladder and leather. *glaffes.*

29. In the laft place come the inftruments for making certain utenfils, as cores for muffles; moulds for tefts, crucibles and melting-pots; and iron-rings for cutting glaffes, and the necks of retorts.

30. The more immediate apparatus, or that directly emply'd in the operations themfelves, are veffels containing the fubjects to be wrought upon; as particularly glafs-eggs and bodies for digeftion; retorts and receivers for *Retorts, re-* diftillation; blind-heads, for bodies, in fublimation; ftone-pans and cut glaffes *ceivers, &c.* for evaporation; peculiar fpout-receivers and glaffes for feparation; ftrainers for percolation; paper for filtration; muffles and tefts for cupellation; cru- *Crucibles,* cibles for melting; pots for cementing; and lutings to clofe the junctures of *&c.* the veffels. A compleat fet of thefe feveral utenfils make the apparatus of the portable furnace, and fit it for all the ufual operations of chemiftry.

31. The *materia chemica*, that is, the fubjects to be work'd upon, or im- *The materia* mediately and materially employ'd in chemical operations, is the next thing *chemica* to be confider'd. This is a large field, and comprehends all the natural *claffed.* bodies of our globe; which are all fubject-matters of chemiftry. We can therefore only felect for a portable laboratory, fuch of them as are moft neceffary, or difficult, to be procured, efpecially at any diftance from large trading cities, and populous towns. This collection being diftributed into pro-

per classes, will come into a small compass; and may be commodiously carried, either by Land or Sea, along with the furnace and its utensils.

32. We shall attempt to range it under the three heads of vegetable, animal and mineral substances; and to fit it for general use. But if any one desires to enlarge or improve his collection, he might do well to observe some certain order, or proceed in the manner pointed out by *Becher*, in his subterraneal physics *(f)*; as what was long practised by himself to advantage.

33. *Becher* endeavours to range all chemical subjects under eight general classes; *viz.* metals, minerals, decompounds, salts, gums, earths, stones, spirits and oils.

(1.) The class of metals contains gold, silver, copper, iron, tin, and lead, both in their natural and artificial state; that is, both in their ores, and as they are separated and purified for human uses. Add to these the artificial, compound or mix'd metals; as pewter, bell-metal, brass, gun-metal, pin-metal, *Bath*-metal, *Wells*-metal, princes-metal, *London*-metal, white copper, white gold, yellow silver, *&c.*

(2.) Under minerals are included antimony, bismuth, zink, marcasite, cobalt, zaffera, manganese, arsenic, orpiment, realgar, virgin-mercury, native cinnabar, sulphur, *&c.* and these both pure and in their natural mine.

(3.) The decompounds of minerals include *aurum fulminans*, *luna cornua*, the calces of gold and silver, ultramarine, distill'd verdigrease, burnt copper, putty or calcin'd tin, sugar of lead, cadmia, tutty, black-lead, red-lead, litharge, white-lead, glass of lead, simple and martial regulus of antimony, glass, cinnabar, *&c.* the preparations of quick-silver, as artificial cinnabar, mercury-sublimate, precipitate, *&c.* And in the same manner may the decompounds of vegetable and animal substances be commodiously ranged.

(4.) The class of salts takes in sea-salt, nitre, vitriol, alum, borax, tartar, sugar, soda, pot-ash, and the compound saline fluxes for stubborn ores. Add to these the tribe of artificial salts, as *tartarum vitriolatum*, fix'd nitre, soluble tartar, *terra foliata tartari*, *nitrum nitratum*, sal-ammoniac, *Epsom*-salt, volatile salts, *&c.*

(5.) Under gums are ranked pitch, rosin, turpentine, wax, camphire, amber, pit-coal, jet, bitumens, balsams, and inspissated juices.

(6.) Earths take in ores, wash'd ores, fluds, calces of metals, lime, plaister, gypsum, chalk, boles, shells, sands, and all those commonly called earths, whether calcarious or vitrescible.

(7.) Stones include flints, pebbles, quarry-stone, crystal, talcs, the vulgar stones, and all the gems, from the diamond to the crystal and *fluores metallici.*

(8.) Lastly, under spirits and oils come *aqua fortis*, *aqua regia*, oil of vitriol, spirit of salt, spirit of nitre, spirit of sulphur, spirit of alum, spirit of vinegar, spirit of wine, spirit of urine, spirit of tartar, spirit of turpentine, oil of tartar *per deliquium*, &c. essential vegetable oils, as of nutmeg, cinnamon, *&c.* express'd vegetable oils, as of linseed, olives, almonds, *&c.* the compound oils, as butter of antimony, unguents, artificial balsams, *&c.*

34.

(f) *Physic. subterran.* Becher, p. 187.

34. And in this manner *Becher* advises the young operator to procure for himself an alphabet of nature, that is, a suitable collection of the *materia chemica*; and to proceed regularly with it, as he would do in learning to read, by composing first syllables, then words, and lastly discourses out of his alphabet; *viz.* by forming these various bodies into mixts, compounds, and decompounds.

And the laboratory set in order.

35. But to avoid miscarriages, and prevent being impos'd upon, he farther directs an acquaintance to be cultivated with the productions of nature in their crude state, or peculiar places of growth; where being first view'd and examined, before they are gather'd or dug up, an exact knowledge of them may be procured. For want of this qualification, men, otherwise of great sagacity, have err'd in their operations, by using a wrong, an adulterated or imperfect subject instead of the true; whence numberless complaints of failure and uncertain success in the business of chemical experiments. For, as it is a maxim in the law, that every circumstance affects and alters the case; so a mistake in the least circumstance; as to time, order, or the genuineness of the subject, may affect and alter a whole chemical operation (*g*).

36. To this he adds another caution, as to the making a prudent and sufficiently copious collection; which being always ready at hand, may prevent sending to the druggist at every turn; where perhaps the things demanded are either not to be had, or at best not without sophistication: whence many processes intended, have been obstructed, entirely prevented, or never brought to a trial.

37. But when the alphabet of nature, like the letter in a printing-house, is distributed and lodged in its proper cells, it may readily be drawn out for use, as occasion requires. And so much as a good collection of this kind facilitates the practice of chemistry, and renders it pleasurable; so much is it render'd irksome and disgustful by the want thereof. *Becher* ingenuously declares the satisfaction he receiv'd from the use of a well-appointed laboratory, in the following words. "'Tis impossible to express with how "little expence, and trouble, yet to what pleasure and profit, numerous "experiments, tho' of the most difficult kind, may be made, when the "operator has all his matters ready about him. I have sometimes gone "through fifty different experiments in a day: and even, whilst I am "writing, if any difficulty, requiring an experiment, arises, I immediately "get up, and make it; my materials for the purpose standing at my elbow, "whilst I sit at my desk: so that 'tis as agreeable and easy for me to per-"form an operation with the furnace, as to describe one with the quill (*h*)." And this end it is hoped may be answer'd, by means of the portable laboratory here described.

(*g*) *See* Becher's *Physic. subterran.* p. 189. (*h*) *Ib.* 190.

SECT. III.

Directions for the application of the Portable Laboratory to the improvement of Chemiſtry.

The manner of uſing the laboratory.

1. THE laboratory being procured and ſet in order, we come, in the laſt place, to direct the manner of uſing it. And this view will lead us to ſketch out ſome particular methods for extending and improving chemiſtry itſelf; or repreſenting it as an art, beyond expectation, ſuited to the entertainment of gentlemen, philoſophers, ſcholars and perſons of employ.

2. But all at preſent propoſed is barely to ſhew the paths that lead to the immenſe regions of chemical knowledge; without pretending to conduct the reader thro' them, any farther than by pointing to ſome few of the principal guides that may be ſafely follow'd in this purſuit.

3. Thoſe who are not yet informed in the common chemical proceſſes, would do well to conſult the learned *Boerhaave*'s new method of chemiſtry; which in a plain, familiar manner, delivers an inſtructive and uſeful courſe of operations; all of them commodiouſly performable upon the portable furnace. And ſuch a courſe appears to be a ſuitable introduction to the ſublimer chemiſtry of *Boyle*, *Becher*, *Homberg*, and *Stahl*; and a good foundation for its farther advancement.

For the improvement of philoſophy and arts.

4. Whoever would proceed farther, may direct his chemiſtry to the improvement of philoſophy, arts, ſciences, trade, and commerce: for the promoting of which end, we here offer a few ſchemes of courſes, which, with numerous others, are alſo performable upon this portable furnace.

I.

Scheme for a courſe of general Chemiſtry: or an Introduction to the ſeveral branches of chemical knowledge.

I.

In the way of ſeparation.

Analyſis in general.

I. THE common methods of analyſing vegetable, animal, and mineral ſubſtances; to ſhew the matters into which they are ſeparable by the artificial application of fire, both in their natural ſtate, and after they have been alter'd by fermentation, putrefaction, or corruption.

Hence an explanation of the chemical principles; and a notion of the ſtructure of matter; with its uſes in natural philoſophy, and arts.

The beſt aſſiſtance in this affair ſeems derivable from Mr. Boyle'*s Sceptical Chemiſt*, Becher'*s Subterraneal Phyſics*, *M.* Homberg'*s Eſſays upon the Principles*, *the numerous analyſes of the Royal Academy of Sciences at* Paris; *and the reſult of their doctrine, improved by M.* Homberg.

(1.)

(1.) *Vegetable Subjects.*

II. The manner of procuring the waters and essential oils of vegetables, in perfection; or the history of distillation *per vesicam.* *Common distillation.*

(2.) The method of procuring distill'd waters, brandies, and spirits.

(3.) The history of chemical oils; and their uses to the perfumer, the apothecary and private persons.

The foundations for this subject seem well laid by Dr. Boerhaave, *in his* New Method of Chemistry; *and Dr.* Hoffman *in his* Observationes Physico-chemicæ. *There are also some occasional papers relating to it in the Memoirs of the Royal Academy*; *particularly by M.* Homberg, *and M.* Geoffroy.

III. The simple solutions, tinctures, infusions, decoctions, robs, laques, and extracts of vegetables; for the uses of brewing, the art of dying, the art of painting, and the service of a family. Whence an entrance is made into the grand doctrine of menstruums, solution, extraction, and simple mixture. *Simple tinctures, infusions, &c.*

Most of the common chemical authors have treated these processes, but without shewing the extensive uses thereof; *as having chiefly confined themselves to pharmaceutical views. Among the principal to be recommended upon this head, are* Glauber, Boyle, Becher, Kunckel, Le Mort, Homberg, Hoffman, *and* Boerhaave.

IV. The dry distillation or sublimation of vegetables; whence the perfect manner of refining camphire, and an experimental inquiry whether essential oils are convertible into camphire, and camphire into essential oils: with the uses of this discovery to physicians, apothecaries, druggists, and chemists. *Dry distillation, or sublimation.*

This subject has been little touched by authors, and at present lies obscured in uncertainty; *the dispute about the nature, production, and refinement of camphire remaining unsettled: as to which point,* le Febure, *the elder* Lemery, *and some late papers in the Philosophical Transactions may be consulted, and compared with the opinions of Mr.* Boyle, Boerhaave, Homberg, *and other members of the Royal Academy, relating to this affair.*

V. The common processes of malting all vegetable grain, for potable liquors, and corn-spirits. Whence an explanation of the nature of seminal vegetation; and an introduction to the art of brewing. *Malting.*

Boerhaave *in his* New Method of Chemistry *has given an introduction to these processes*; *but they have otherwise been little considered by philosophers or chemists. There are however some papers relating hereto in the Philosophical Transactions, that well deserve to be consulted.*

VI. The methods of fermenting malted grain, and vegetable juices, into drinks, wines, and vinegars; with the art of procuring and refining essential salts and tartar. *Fermenting.*

Hence a rational history of vinous and acetous fermentation; the diseases of wines, and their cures.

Boerhaave *has open'd this subject, in his* New Method of Chemistry; *but* Stahl, *in a peculiar treatise, has carried it farther, with a view*

to

to philoſophy and practice. Some hints relating to it may likewiſe be found in Glauber, *Mr.* Boyle, *the Philoſophical Tranſactions, the* German *Ephemerides, Mr.* Evelyn, *the* Vinetum Britannicum, *Dr.* Merret, *&c.*

The making of ſugar. VII. The proceſſes for reducing vegetable juices to ſugars; by expreſſion, decoction, clarification, graining, claying, and cryſtallization.

For directions in the ſeveral proceſſes of this art, ſee Piſo's Hiſtor. Ind. Angelus Sala *in his* Saccharologia, *Dr.* Slare *on Sugars, and Sir* Hans Sloane's Natural Hiſtory of Jamaica. *Add to theſe, ſome papers in the Philoſophical Tranſactions.*

The making of nitre, or ſalt-petre. VIII. The method of procuring nitre from vegetables, *&c.* and purifying it for gunpowder, and other uſes.

To this purpoſe ſee Glauber, Clarke, *and* Stahl *on nitre; and compare them with the diſcourſe of the younger* Lemery *upon the origin of this ſalt.*

The making of volatile ſalts, and ſal-ammoniac. IX. The method of procuring volatile ſalt from vegetables, for various uſes, and fit to compoſe ſal-ammoniac, for the purpoſes of dyers, braziers, apothecaries, and chemiſts.

With this view, conſult the extraordinary paper of Dr. Cox *upon the ſubject of volatile ſalts, in the Philoſophical Tranſactions;* Boerhaave's *hiſtory of vegetable putrefaction, and his account of ſal-ammoniac; and compare them with the papers of Meſſieurs* Lemery *and* Geoffroy *upon the manner of preparing this ſalt in the* Levant, *and imitating it in other countries, as well as nitre.*

The procuring of wax, tar, pitch, roſin, &c. X. The method of treating vegetables for their wax, honey, gums, tar, pitch, turpentine, oil, roſin, and colophony.

Some accounts to this purpoſe are met with in the writers of travels and natural hiſtory; but the foundation of the thing may be ſeen in Boerhaave's Chemiſtry, Pomet, *and* Lemery's Hiſtory of Drugs, *or rather among the writers of natural hiſtory.*

The making of charcoal. XI. The method of charring vegetables for fewel, ſo as to burn without ſmoke; and to be of uſe for the drying of malt, or other curious, chemical, and œconomical purpoſes.

Glauber, *Mr.* Boyle, *Mr.* Evelyn, *and the Philoſophical Tranſactions, contain ſome particulars to this purpoſe.*

The making of pot-aſh. XII. The art of reducing vegetables to pot-aſh, for the ſervice of the ſoap-maker, fuller, ſcourer, dyer, glaſs-man, chemiſt, apothecary, *&c.*

Glauber, *in his* Proſperity of Germany, *and elſewhere, has ſome uſeful obſervations relating to this ſubject; which is alſo conſidered by ſeveral of our naturaliſts: but the chemical foundation of the whole may be readily learn'd from* Boerhaave, *or other good writers of general courſes.*

(2.) *Animal Subjects.*

The animal principles. XIII. The common reſolution of animal ſubſtances into their principles, pure and mix'd, for the uſes of medicine and various arts.

See Boyle's *Hiſtory of Human Blood, his Sceptical Chemiſt,* &c. *Dr.* Cox's *papers in the Philoſophical Tranſactions,* Boerhaave's *proceſſes upon animals, and* Stahl's Philoſophical Principles of Chemiſtry.

XIV.

XIV. The manner of ſeparating the more medicinal parts of animals, in the way of ſimple ſolution, tincture, gelly, *&c.* for the uſes of the apothecary. *Gellies, glews, &c.*

This ſubject has been little treated in a philoſophical view; but receives ſome light from Boerhaave's *Proceſſes upon Animals, Mr.* Boyle's *Experiments on human blood, the Uſe of* Papin's *Digeſtor, and the common pharmaceutical chemiſtry.*

XV. The manner of ſeparating and purifying the fat of animals, for the uſes of the ſoap-boiler, chandler, clothier, *&c.* *Preparing fats.*

The difficulty here lies in taking off the nidorous odour of coarſe, animal oils, or fats; and rendering them fit for the finer uſes, as in the making of Sperma Ceti *from train-oil,* &c. *And in this affair, the methods delivered by many chemical authors, for rectifying and purifying ſome empyreumatic oils, may be of ſervice: but more commodious methods for practice are ſtill required.*

XVI. The method of ſeparating phoſphorus from animal ſubjects; and reducing them to a kind of lamp-black, aſhes and earth, for the uſes of painting, dying, printing, colouring, aſſaying, *&c.* *Phoſphorus and virgin-earth.*

The affair of the animal phoſphorus is deliver'd by Mr. Boyle *and M.* Homberg; *and the ſoot, the black, the aſhes, and the earth, are touched upon by* Boerhaave, *and others.*

(3.) *Mineral Subjects.*

XVII. The general methods of reducing mineral-juices to a dry ſubſtance; ſo as to come at the ſolid matter they contain; with a view to the art of mining, or the diſcovery of metalline-veins, the erection of ſalt-works, vitriol-works, alum-works, borax-works, *&c.* *The art of condenſing mineral juices.*

This ſubject is proſecuted by George Agricola, *at the cloſe of his work* de re metallica: *and the view is carried farther by Mr.* Boyle, Becher, Stahl, Homberg, *and ſome other members of the Royal Society, and the Academy of Sciences.*

XVIII. The manner of reducing ſolid mineral ſalts to fluid acid ſpirits, by ſeparation or diſtillation; for the numerous uſes of dying, etching, aſſaying, the preparation of menſtruums for metals, and many other ſubjects. *Preparation of acid mineral menſtruums.*

The proceſſes for this purpoſe are deliver'd by all writers of chemical courſes; but the rationale, and the juſt application of the productions to mechanical, philoſophical, and chemical uſes, are ſparingly touched upon by them. Thoſe who would go deeper in this affair, may conſult Dr. Stahl's Principles of Chemiſtry, *Mr.* Boyle's Eſſay upon Nitre, *and M.* Homberg's *Paper on Acid Spirits. Add to theſe,* Agricola, de re metallica, *and others who have wrote upon the buſineſs of aſſaying.*

XIX. The general method of analyſing ſolid minerals; or reſolving them into flowers, ſulphur, arſenic, earth and metal, or any other particular ſubſtance they may contain; with a view to philoſophical minerology, and the vulgar art of metals; or the procuring all mineral ſubjects in their pure, ſeparate, and artificial ſtate. *Analyſis of ſolid minerals.*

Thoſe

Thoſe who deſire to ſee how this buſineſs is treated at the mines, may find an entertaining account of it in George Agricola's *work* de Re metallica. *There is alſo a good deal to the ſame purpoſe delivered up and down in the writings of* Paracelſus, Helmont, Glauber, Ercker, *and Mr.* Boyle. *But among the capital performances, in the philoſophical and chemical parts of this affair, ſtands that of* Becher, *call'd his* Phyſica ſubterranea, *eſpecially as it is improved by the labours of Dr.* Stahl.

The deſign of this courſe has hitherto been to ſhew the general manner of ſeparating from chemical ſubjects, whether vegetable, animal, or mineral, the diſtinct, ſimilar, or homogeneous parts that enter their compoſition; ſo as to procure them ſimple, and fit for uſe. All theſe productions, therefore, are ſo many artificial things, obtain'd by a chemical reduction of natural bodies; which, as well as the artificial, may be compounded and recompounded by art, like the letters of the alphabet, into many thouſands, or even millions of new and unknown bodies; all of them creatures of chemiſtry: which ſhews the great power and extent of this art.

II.

In the way of combination.

Syntheſis. Among the experiments relating to the combination of vegetables with vegetables, may come,

The uniting of vegetable oils with water, &c. XX. The ways of combining eſſential oils with vegetable waters, ſugars, and inflammable ſpirits, for various uſes.

See Boerhaave's *New Method, and* Stahl's *Philoſophical Principles of Chemiſtry.*

Making of ſoaps. XXI. The methods of combining vegetable oils and vegetable ſalts into ſoaps, and the *ſales volatiles oleoſi*; for the purpoſes of medicine, a family, and ſeveral trades.

Conſult, upon this head, Starkey *on the ſoap of tartar,* Boerhaave's *Chemiſtry, and* Homberg's *paper deſcribing a particular ſoap for taking away freckles.*

Making of neutral ſalts. XXII. The ways of combining fix'd and volatile vegetable ſalts with vegetable acids; ſo as to make artificial neutral ſalts, of ſingular virtues and uſes.

Many curious particulars relating to this purpoſe, are found in Mr. Boyle's *Philoſophical Works, the* French *Memoirs, and the Philoſophical Tranſactions.*

Spirit of wine united with vegetable acids, &c. XXIII. The method of combining inflammable ſpirits with vegetable acids, and with roſins, for medicinal and mechanical uſes; ſhewn in the art of wines, brandies, and the making of compound varniſhes.

This ſubject receives ſome light from the common proceſſes of chemiſts, for dulcifying acid ſpirits; and making the ordinary tinctures: but its more extenſive uſe muſt be derived from the philoſophical chemiſts, as Boyle, Homberg, *and thoſe who deſcribe the arts of diſtillation and japanning.*

Experiments

Experiments relating to the combination of vegetable with animal ſubjects.

XXIV. The method of combining animal or vegetable ſalts, and roſins, with alcohol, brandy, wine, vinegar, or water; for the uſes of pharmacy and other arts. *Alcohol with ſalts.*

The common chemical books are full of proceſſes to this purpoſe; as Le Febure, Le Mort, Lemery, Wilſon, Barchuſen, *and* Boerhaave.

XXV. The ways of combining fix'd ſalt and animal fat into ſoap; blood and fix'd ſalt into a blue pigment; animal fleſh and vegetable balſams into mummy; with other particulars of this nature. *Animal fat with fixt ſalt, &c.*

See Boerhaave'*s chemiſtry, and the Philoſophical Tranſactions.*

Experiments relating to the combination of animal with mineral ſubjects.

XXVI. The method of combining various minerals with animal oils, and fats, into unguents, plaiſters, and paints. *Plaiſters, and paints.*

The common diſpenſatories have the proceſſes for this purpoſe; but the philoſophy of them muſt be derived from chemical authors; as particularly Boyle, Becher, *and* Boerhaave.

XXVII. The method of re-compounding or reſtoring the calces of metals, by the addition of a little animal, or vegetable fat: whence an experimental inquiry into the phlogiſtic principle of Dr. *Stahl*; with its uſe in the buſineſs and philoſophy of metals. *Reduction of metals from their calces.*

XXVIII. The way of rendering alkaline animal ſalts neutral, or turning them into ſal-ammoniac, by combining them with the ſpirit of ſea-ſalt. *Making of ſal-ammoniac.*

See the diſpute betwixt Geoffroy *and* Lemery, *about the preparation of ſal-ammoniac, in the* French *Memoirs.*

Experiments relating to the combination of vegetable with mineral ſubjects.

XXIX. The ways of combining vegetable ſalts with mineral ſulphurs; whence the ſeparation of metals from their ores, and the production of numerous kinds of ſlags or ſcoriæ; with their chemical and philoſophical uſes. *Salts united with ſulphurs.*

Upon this head conſult Agricola, de Re metallica, Ercker, *and other chemical writers upon mines and minerals:* Boerhaave *in the hiſtory of antimony; and* Stahl *in his ſeveral pieces of metallurgical chemiſtry.*

XXX. The ways of combining fix'd vegetable ſalts with mineral earths; whence the foundation of the art of glaſs, and the art of metals; with the philoſophy of vitrification and metallization. *Vegetable ſalts with mineral earths.*

See upon this head Boyle *of gems*; Neri'*s art of glaſs, with* Kunckel'*s notes; and* Stahl'*s pieces of metallurgical chemiſtry; as alſo his comment upon* Becher'*s Subterraneal Phyſics.*

XXXI. The ways of combining metalline matters with vegetable liquors; whence many medicinal tinctures, or ſolutions, of metals, and the whole buſineſs of inks. *Vegetable liquors with metals.*

See Boerhaave'*s Chemiſtry*; *and* Homberg'*s Experiments upon this ſubject*, apud du Hamel, in Hiſtor. Academ. Regal. Pariſienſ.

Experiments relating to the combination of mineral with mineral ſubjects.

Mineral acids with metallic matters. XXXII. The ways of combining the mineral acids with metallic matters; whence the numerous tinctures, ſolutions, ſublimates, præcipitates, calces, &c. of gold, ſilver, mercury, lead, iron, &c. with their extenſive uſes.

All the chemical authors have more or leſs treated this copious ſubject.

Minerals with metals. XXXIII. The general ways of combining minerals with metals; as ſulphur with iron, arſenic with gold or ſilver, calamy with copper, &c. whence various diſcoveries as to the philoſophy of metals; and the natural compoſition of ores and mineral ſubſtances, which are thus imitated by art.

See upon this head Becher, *and* Stahl, *in particular.*

Metal with metal. XXXIV. The art of combining metal with metal, in the way of electrum; or making the mix'd metals.

Much light is given to the philoſophical part of this buſineſs by Mr. Boyle, *and M.* Homberg; *tho' the practical part of it has generally fallen into mechanical hands. But* Agricola, Ercker, Glauber, Becher, *and* Stahl *may be conſulted upon it.*

Experiments relating to the combinations of ſubjects of the three kingdoms promiſcuouſly.

Promiſcuous mixtures. XXXV. The combination of nitre, coal and ſulphur into gunpowder; fix'd vegetable ſalt, ſand and metal into glaſs of all colours; nitre, ſalt of tartar, and ſulphur into the *pulvis fulminans*; ſal-ammoniac, and quick-lime into a certain phoſphorus; alum, wheat-flower, or other vegetable or animal ſubſtances, into the common black phoſphorus: with numerous examples of the ſame general nature.

And in this view all the original chemical authors ſhould be conſulted; not omitting even thoſe called the adept, from Hollandus, Valentine, Lully, *Friar* Bacon, Paracelſus, Helmont, &c. *down to* Boyle, Philaletha, Becher, Homberg, *and* Stahl. *Add to theſe, the authors who have wrote upon particular trades; requiring the joint aſſiſtance of ſubjects from all the three kingdoms.*

New menſtruums from mixture. XXXVI. Experimental attempts to direct the farther combination of ſubjects, and productions, of the three different kingdoms; with a view to diſcover new ſolvents, or mixtures, for the purpoſes of medicine, the mechanic arts, and the farther uſes of life.

Little to this purpoſe has hitherto been done by any ſingle author; and indeed a proper work of the kind requires the joint labour of many. But Mr. Boyle, *and* Boerhaave *have open'd the affair; and certain members of the Royal Academy and Royal Society have purſued it. See* Boyle paſsim, *and* Boerhaave'*s chapter of menſtruums.*

XXXVII.

XXXVII. Experiments relating to the recompofition of bodies, or combining their feparated principles together, fo as to compofe the original concrete again. *Recompofition.*

See Mr. Boyle'*s Experiment upon Nitre, M.* Homberg'*s Effays, and Dr.* Stahl, *both in his Philòfophical Principles of Chemiftry, and his* Opufculum Chymico-Phyfico-Medicum.

II.

Scheme for a Courfe of Philofophical Chemiftry; or, the application of Chemical Experiments to the improvement of Natural Knowledge.

I. AN experimental inquiry into the chemical nature, and internal ftructure of matter, in the different aggregates, or maffes of animals, vegetables, and minerals; compared with the experiments and obfervations of *Boyle*, *Becher*, *Hook*, *Newton*, and fome other members of the royal fociety, and royal academy of fciences. *Chemical ftructure of matter.*

II. An experimental view of the various ftates and forms into which matter is reducible by chemiftry; as to fluidity and folidity, exhalations, vapours, heat, cold, gravity, denfity, hardnefs, foftnefs, colour, confiftence, odour, *&c.* *Various fchemes or forms of matter.*

Under this head Mr. Boyle *has perform'd fomething confiderable upon the Lord* Bacon'*s Plan*; *and feems, in a manner, to have engrofs'd the fubject.*

III. A view of the different relations, vulgarly call'd fympathies and antipathies, or attractions and repulfions, obferv'd betwixt different bodies; with the ufes of this doctrine in philofophy, and chemiftry. *Secret relations of the different fchemes of body.*

See Boyle, Hook, Homberg, Newton, Stahl, *and the* Memoir *of* Geoffroy *in the Works of the Royal Academy for the Year* 1718.

IV. An experimental inquiry into the real principles of natural bodies; how far the fire gives a juft analyfis, and how far it fails therein; whence the doctrine of chemical feparation and combination may be juftly fettled. *Principles of bodies.*

Among the principal authors to be confulted upon this head are Bacon, Boyle, Becher, Homberg, *and* Stahl.

V. An experimental inquiry into the bufinefs of mixture, uatural and artificial; or the beft and moft intimate manner of uniting folid with folid, folid with fluid, fluid with fluid, *&c.* according to the ends for which they are defign'd. *Doctrine of mixture.*

Great light may be derived in this inquiry from the Works of Mr. Boyle, Becher'*s* Subterraneal Phyfics, Stahl'*s Comment thereon, and his* Paper *upon Mixts, Texts and Aggregates, publifhed in his* Opufculum Chemico-Phyfico-Medicum, *and the* Obfervationes Hallenfes.

Explanation of the nature and office of chemical operations.

VI. A philofophical explanation, and experimental illuftration of all the chemical operations, as fo many means of effecting certain changes in bodies, according to certain rules, for the various purpofes and intentions of the art.

Something of this kind was attempted by Dr. Friend, *in his* Prelectiones Chemicæ; *but the view is enlarged by* Boerhaave *and* Stahl: *yet well deferves to be farther profecuted, as it includes no inconfiderable branch of natural philofophy.*

Chemical operations improved.

VII. An experimental attempt to improve the chemical operations; fo as to render them capable of performing what could not otherwife be expected from them.

Mr. Boyle *has many curious hints to this purpofe*; *fo has M.* Homberg: *but the thing is more fully confidered by Dr.* Stahl, *in his comment upon* Becher; *and in feveral of his* Schediafmata.

Doctrine of menftruums.

VIII. A fet of experiments to unfold the ufeful and extenfive doctrine of menftruums; or the bufinefs of adapting folvents to all kinds of bodies.

Mr. Boyle *affords many improveable hints to this purpofe*; *and* Boerhaave's *chapter of menftruums may ferve as an introduction to the inquiry.*

Nature and ufes of fermentation and putrefaction.

IX. Experiments to difcover the nature and ufes of fermentation and putrefaction in the fyftem of the world; as they are natural means of converting one body into another.

See Boerhaave's *Chemiftry*, Boyle's *philofophical Works*, Becher *in his* Phyfica fubterranea, *and Sir* Ifaac Newton's *Quæries, at the end of his Opticks.*

The doctrine of acid and alkali.

X. Experiments to adjuft, eftablifh, and illuftrate the doctrine of acid and alkali.

See Boyle, Bohn, Homberg, Boerhaave, Stahl, *and* Newton's *paper upon the fubject, publifh'd in* Harris's Lexicon Technicum.

The doctrine of the four elements.

XI. A fet of introductory experiments, to fhew the general nature, offices, and ufes of the elements in the fyftem of the world.

This article is touch'd upon by the Lord Verulam *and Mr.* Boyle, *reconfidered by M.* Homberg, *and* Boerhaave; *and in fome particulars improv'd by Sir* Ifaac Newton.

The nature of fire and heat.

XII. A fet of chemical experiments to unfold the nature of fire and heat; with the modus of their operation upon bodies, for the production of various effects.

A foundation for this inquiry is laid by the Lord Bacon *in his* Novum Organum, *and improved by Mr.* Boyle, *M.* Homberg, Bohn, Boerhaave, Lemery, *and* Swedenbourg.

Nature of the atmofphere.

XIII. A fet of chemical experiments to difcover the ingredients of the atmofphere; and account for its various effects, operations, and phænomena; with regard to bodies lodged or digefted therein.

This fubject has been profecuted by Mr. Boyle; *and feems brought to a little fyftem by* Boerhaave, *in his chapter of air, confidered as a chemical inftrument.*

XIV. An experimental inquiry into the nature of water, its office and uſes in the globe; the origin of hot and cold ſprings, the ſaltneſs of the ſea, and the different kinds of mineral waters. *Nature of water.*

See Mr. Boyle, Becher, Liſter, Boerhaave, Newton, Bernoulli, Stahl, *and* Hoffman.

XV. Experiments to ſhew the nature and uſes of earth, conſidered as an element. *Nature of elementary earth.*

Among the beſt guides in this affair muſt again be reckon'd Boyle, Becher, Boerhaave, Newton *and* Stahl.

XVI. Attempts to imitate various phænomena of the atmoſphere; as thunder, lightning, coruſcations, the *aurora borealis*, water-ſpouts, rain, hail, ſnow, *&c.* *Nature and imitations of meteors.*

See the paper of M. Lemery *ſen.* Memoir de l'Academ. An. 1700. *and compare it with the diſcoveries of Mr.* Boyle, *M.* Homberg, *Sir* Iſaac Newton, *and certain papers in the* Philoſophical Tranſactions, *relating to this article.*

XVII. Attempts to imitate ſome natural phænomena proceeding from cauſes within the earth; as ſubterraneal heats, fires, fumes, eruptions, vulcanos, earthquakes, boiling waters, *&c.* *Subterraneous phænomena.*

See the writings of the naturaliſts, particularly Dr. Woodward; *and compare them with the experiments and diſcoveries of Mr.* Boyle, *Sir* Iſaac Newton, *and Meſſieurs* Homberg, Lemery, Geoffroy, *and Dr.* Hoffman.

XVIII. A chemical inquiry into the buſineſs of vegetation, animalization, and mineralization; or the growth, nouriſhment, natural decays and changes of vegetable, animal, and mineral bodies. *Nutrition and growth of bodies.*

See the experiments of Woodward *and* Homberg *upon Vegetation*; Digby *on Nitre*; Evelyn *on Agriculture*; Cox *and* Boerhaave *on Putrefaction*; *and* Boyle, Becher, *and* Stahl *upon the origin, growth, and formation of ſubterraneous bodies.*

XIX. Chemical experiments relating to the human body, in its natural healthy ſtate, or the various chemical operations perform'd therein. The nature of the ſeveral animal fluids; the changes they undergo; their mixtures, ſeparations, uſes, and effects upon each other, and upon the whole, ſo as to maintain a healthy ſtate. *Natural chemiſtry in the body.*

With this view conſult Boyle, Bohn, Boerhaave, *and* Hoffman.

XX. Experiments relating to the nature of morbid juices, or fluids diſplaced, concreted, fuſed, or alter'd in the body; and to the cauſes and cures of diſeaſes by peculiar ſolvents or ſpecifics. *The morbid fluids of the body.*

Conſult upon this head Mr. Boyle*'s diſcourſe of ſpecific Remedies*, Boerhaave*'s chapter of menſtruums, and certain papers in the* French *Memoirs, attempting to diſcover ſolvents for the ſtone in the bladder*, &c.

XXI. Experiments to determine *a priori* the nature and medicinal virtues of mineral waters. *Mineral waters.*

See

See Mr. Boyle *upon the ſubject, and compare him with Dr.* Hoffman; *by which means a foundation may be laid for a due proſecution of this affair.*

New powers to be uſed in chemiſtry. XXII. An attempt to introduce ſome new inſtruments into chemiſtry, for the more exact performance of certain operations, both in the way of ſeparation and combination; particularly the inſtrumental agency of cold, and the powerful furnace of the Sun.

Upon this head conſult the Lord Bacon, *and Mr.* Boyle; *and with their diſcoveries compare the experiments of M.* Homberg *and Dr.* Stahl, *as to the effects of high degrees of cold and heat in chemical operations.*

The chemiſtry of nature, at large. XXIII. An attempt to explain the chemiſtry of nature, or the manner wherein the world is continually recruited in all its parts; the earth refreſh'd with dew and rain; the atmoſphere ſtored with vapours, and the ſeeds of vegetables; vegetables ſwelled with moiſture, and expanded by the heat of the ſun; the air furniſh'd with its renovating ſpirit; and fire, air, earth and water conſerved to repair the animal, vegetable, and mineral worlds, and preſerve the divine order and harmony of material things.

This is the favourite topic of philoſophers; which they uſually touch ſucceſsfully. But among the beſt authors upon the ſubject, we rank the Lord Bacon, *Mr.* Boyle, *Dr.* Hook, *M.* Homberg, *Mr.* Ray, *Dr.* Derham, *Mr.* Evelyn, *Dr.* Stahl, *and Sir* Iſaac Newton.

III.

Scheme for a Courſe of Pharmaceutical Chemiſtry: or the Art of preparing medicines.

(I.)

An introduction to the pharmaceutical operations; ſhewing the inſtrumental efficacy of fire, air, water, and earth therein.

Subjects ſuited to fire. 1. THE ſubjects ſuited to the inſtrumental efficacy of fire; *viz.* volatile fluids, volatile ſolids, inflammable, fuſible, calcinable, and vitrifiable bodies.

Air. 2. Subjects ſuited to the inſtrumental efficacy of the air; *viz.* relenting ſalts, exhalable bodies, and ſalts diſpoſed to cryſtallize.

Water. 3. Subjects ſuited to the inſtrumental efficacy of water; *viz.* ſalts, mucilages, ſpirits, powders, gums, and all bodies affected by the *Balneum Mariæ.*

Earth. 4. Subjects ſuited to the inſtrumental efficacy of earth; as all ſolid machines, engines, and veſſels form'd of earthy materials. Whence a chemical explanation of trituration, aggregation, ſolution, coagulation, evaporation, cryſtallization, præcipitation, ſublimation, diſtillation, digeſtion, detonation, candefaction, fuſion, incineration, calcination, deliquation, regeneration, congelation, and fermentation of the various kinds, with direct relation to pharmacy.

(II.)

(II.)

The principal ſubjects, and general operations, to be exhibited in a courſe of pharmaceutical chemiſtry.

I. A juſt collection of the *materia medica*; or, (1.) A ſet of dry'd medicinal herbs, flowers, fruits, ſeeds, roots, barks, and woods. (2.) Dry'd parts of animals; or animal ſubſtances having any medicinal virtue. (3.) A ſet of medicinal foſſils; all diſtributed into proper claſſes. *The materia pharmaceutica.*

General pharmaceutical operations upon vegetables.

II. Experiments to ſhew how any crude, vegetable ſubjects, being barely cut, bruiſed, or reduced to powder, may have their whole ſubſtance made into ſpecies, candies, confections, conſerves, cataplaſms, pills, or electuaries; by diſtillation, into waters and eſſential oils, and with a ſcorching heat into empyreumatic oil: by decoction, in water or ſpirit of wine, into tinctures, eſſences, and extracts; and by expreſſion, or long continued coction, into oils. *Operations upon vegetables in ſubſtance.*

III. To ſhew how eſſential, vegetable oils and eſſences are form'd into elixirs, and ſweet ſcented balſams: and how expreſs'd, vegetable oils, boil'd with vegetable juices, gums, roſins or powders, become unguents, liniments, compound oils, or plaiſters. *Eſſential oils.*

IV. To ſhew that moſt vegetable juices and ſeeds yield, by fermentation and diſtillation, an inflammable ſpirit, that becomes compounded by being drawn over from certain ingredients, or impregnated with their virtues; whence the tribe of compound or ſpirituous waters; the rectification of vinous ſpirits; and the preparation of alcohol *per ſe*, and tartariz'd; with various tinctures and ſolutions made by their means. *Productions by fermentation.*

V. That vegetables afford ſalts, call'd eſſential and alkaline, by cryſtallization and incineration, of conſiderable uſe in pharmacy: and that by diſtillation, they yield an empyreumatic oil, an acid ſpirit, and a ſoot. *Vegetable ſalts.*

VI. To ſhew that all ſweet vegetable juices afford wines by fermentation, and afterwards vinegar: whence medicated wines and vinegars, with numerous compound preparations, by means of theſe two menſtruums. *Vegetable juices affording wines and vinegar.*

VII. To ſhew that the ſame inſpiſſated vegetable juice affords, by diſtillation *per ſe*, an acid ſpirit, an empyreumatic oil, a black coal, and afterwards a fix'd ſalt. *Acid ſpirit.*

VIII. That tartar and wine-lees, by the retort afford an inflammable ſpirit, an empyreumatic oil, a volatile ſalt, printer's black, or a peculiar *caput mortuum*, and ſalt of tartar. *Productions of tartar.*

IX. That roſins and gums afford a fine ætherial oil, an empyreumatic oil, a little acid ſalt, an unctuous *caput mortuum*, or a coal that by burning falls to aſhes. *Of roſins.*

General pharmaceutical operations upon animals.

X. To ſhew how the parts of animals are fitted for pharmaceutical preparations, in the form of powders, ſhavings, chips, gelly, a black coal, or a white pulverable ſubſtance produced by philoſophical calcination. *Animal ſubjects prepared.*

XI.

Boil'd, diftill-ed and burnt. XI. That animal fubftances, boil'd in water, make a gelly, fize, or glew; and by burning *in occlufo*, afford a fpirit, oil, volatile falt, and *caput mortuum*, or coal; which being burnt in the open air, affords afhes, containing falt, and elementary earth.

General pharmaceutical operations upon minerals, relating to pharmacy.

Mineral falts diftill'd. XII. Experiments to fhew that mineral falts are refolvable by diftillation *per retortam* into acid fpirits, and an earthy *caput mortuum*; and that certain fulphureous and arfenical minerals may be fublimed, and reduced into fulphur, arfenic, regulus and metal.

Metallic calces diffolv'd. XIII. That certain mineral matters, and metalline calces, diffolve with oil, and form plaifters; that metals with acid fpirits form compound falts; and that fulphurs diffolve with oil into balfams; and with alcohol into tinctures.

(III.)

The particular operations, and more neceffary preparations of pharmaceutical chemiftry.

In the vegetable kingdom.

Diftilled waters. XIV. Rules for the drawing of fimple and compound waters, and effential oils, to the greateft perfection; exemplified by diftilling a frefh medicinal fimple in *Balneo Mariæ*, without any addition of water; certain effential oils, according to the directions of Dr. *Hoffman*; and certain compound waters, according to the practice of the beft diftillers: with the ufes to be made of the refiduum in each procefs; and the common fraudulent practices of fophifticating, adulterating, or debafing thefe preparations.

Brandies. XV. The method of diftilling inflammable fpirits and brandies, from wafh and wines; as malt-fpirit, melafs-fpirit, *&c.* and fitting, or rectifying them for pharmaceutical ufes, in the form of low-wines, proof-fpirit, alcohol *per fe*, and tartarized fpirit of wine: with the extemporaneous method of making fimple and compound waters.

Tinctures with aqueous and fpirituous menftruums. XVI. The beft manner of preparing the medicinal infufions, tinctures, extracts, elixirs and rofins, with aqueous and fpirituous menftruums. As the *vinum abfinthites*, *vinum viperinum*, *vinum emeticum*, *tinctura facra*, *laudanum liquidum*, *elixir proprietatis*, *elixir vitrioli*, *tinctura cantharidum*, *tincturæ formicarum*, *caftorei*, *millepedum*, *mofchi*, *falis tartiri*, *terræ foliatæ tartari*, *&c.* Extract of colocynth, aloes, jalap, fena, hermodactyls, agaric, ipecacuanha, *&c.* according to the experiments and obfervations of M. *Boulduct*, and other members of the *French* academy. Rofin of fcammony, rofin of jalap, rofin of guaiacum, *&c.* with their fophiftications and adulterations.

Vegetable juices how preferved. XVII. The method of preferving vegetable juices in perfection; and of reducing them to fyrups, robs, gellies, and mivas, exemplified in the more ufeful and difficult preparations of this clafs: as the fyrup of violets and rafberries, the rob of elder and juniper, the refiné of *France*, *&c.* with the beft manner of

of making ſyrups by decoction, ſo as to ſecure the particular virtues of the vegetables employ'd; according to the hints of *Charas*, *Boerhaave*, and *Stahl*, with regard to the nature of ſugar, or the diſpoſition it has to imbibe oleaginous or reſinous matters, like ſalt of tartar, and render them ſaponaceous.

XVIII. The methods of procuring the eſſential ſalts of vegetables, and thoſe term'd medicated ſalts, and fix'd ſalts; with the ways of converting the latter into neutrals, or a ſpecies of medicated ſalts, by means of tartar and diſtill'd vinegar: whence the ſoluble tartar, and that curious ſalt called *terra foliata tartari*. Add to this, the methods of neutralizing mineral acids; or recovering ſalts from their acid ſpirits, by means of fix'd, vegetable alkali. *Eſſential ſalts.*

XIX. The beſt methods of making the fix'd ſalts of vegetables for pharmaceutical uſes, and running them *per deliquium*; particularly ſalt of wormwood, ſalt of tartar, and fix'd nitre: with an inquiry into the reaſons of ſubſtituting ſalt of pot-aſh for them; and the ways of uſing theſe ſalts in infuſions and decoctions, ſo as to extract the medicinal parts of the ingredients, without impairing their virtues, or deſtroying their oleaginous and reſinous principles by rendering them too ſaponaceous. Add to this, the method of making fix'd ſalts into cauſtics, for chirurgical uſes. *Fix'd ſalts, and cauſtics.*

XX. The method of making fix'd ſalts into medicinal ſoaps; or uniting them with wax, *ſperma ceti*, balſam of *Peru* and *Tolu*, balm of *Gilead*, balſam *Capivi*, and other fine turpentines or balſams: and this kind of preparation compared with the *Elæoſacchara*. *Medicinal ſoaps.*

XXI. The ways of compounding ſimple oils, wax, gums, balſams, and certain metalline calces into officinal oils, unguents, cerats, and plaiſters, exemplified in the more curious and difficult preparations of this claſs. *Cerats, unguents, and plaiſters.*

(IV.)

Certain ſubjects of the vegetable kingdom, requiring a more particular conſideration.

XXII. An attempt towards a perfect analyſis of the *Peruvian* bark; with the method of making it into the moſt innocent and effectual medicine. *The bark.*

See the Paper of M. Charas *upon this ſubject, in the* Memoirs of the Royal Academy *before its re-eſtabliſhment.*

XXIII. The beſt ways of collecting, purifying, preparing and exhibiting opium. *Opium.*

See the anonymous French Author *on the* Sugar-works *of the* Iſles; Boerhaave'*s* Chemiſtry, *and Dr.* Hoffman'*s* Obſervationes Phyſico-Chymicæ.

XXIV. The beſt ways of purifying, diſſolving, combining, and exhibiting of camphire. *Camphire.*

See Hoffman'*s* Obſervationes Phyſico-Chymicæ, *Dr.* Quincy'*s Pharmaceutical Lectures and Diſpenſatory, and compare them with Mr.* Brown'*s, and Dr.* Newman'*s Papers, upon this Subject, in the Philoſophical Tranſactions.*

Sugar. XXV. A farther application of ſugar to pharmaceutical uſes, as a kind of dry menſtruum, that grinds with balſams, gums, inſpiſſated juices, mercury, metals, *&c.* into powders; which thus become ſoluble in water, and capable of being exhibited with great advantage.

There are ſome hints to this purpoſe in a certain anonymous French Author, *who gives the* Hiſtory of the Sugar-works, *and the* Chocolate-Trade *in the* Iſles.

In the animal kingdom.

Preparing unctuous animal ſubſtances. XXVI. Experiments to ſhew the methods of preparing certain animal ſubſtances for the uſes of pharmaceutical chemiſtry; *viz.* the refining or preparing of the animal fats, as the *adeps viperarum*, *axungia porcina*, *pomatum*, *ſevum cervinum*, *ſevum meliloti*, *butyrum Maiale*, *ſperma ceti*, *&c.* The preparing of millepedes, cantharides, cochineal-flies, iſinglaſs, vipers, rob of urine, dry'd blood, muſk, civet, ſal-ammoniac, *&c.*

Teſtaceous bodies. XXVII. The method of preparing teſtaceous, animal ſubſtances; as oiſter-ſhells, egg-ſhells, pearls, crabs-eyes, crabs-claws, *Bezoar*, *Goa*-ſtone, *Gaſcoign*'s powder, *&c.*

Horn and bone. XXVIII. Experiments to ſhew the effects of decoction and calcination in animal ſubſtances; particularly in hartſhorn for gelly, and the *decoctum album:* with the pharmaceutical hiſtory of animal gellies; and the calces of animal bones.

XXIX. The methods of procuring the volatile urinous ſpirits, ſalts, and oils of animal ſubſtances; as hartſhorn, blood, urine, *&c.* and rectifying or purifying them in the beſt manner, and converting the ſalt into ſal-ammoniac for medicinal uſes.

Silk, &c. XXX. The preparations from raw-ſilk, vipers, and ſome other curious animal ſubjects.

Sal-ammoniac. XXXI. The various preparations with ſal-ammoniac; particularly volatile ſpirits, ſalts, and the *ſales volatiles oleoſi*, ſimple, compound, and extemporaneous; its acid ſpirit, diuretic ſalt, ſecret ſalt, and double menſtruum, as they are called; with the general method of ſubliming metalline and mineral bodies by its means.

In the mineral kingdom.

Sulphur. XXXII. Experiments to ſhew the manner of ſeparating and purifying ſulphur, by ſublimation; and the method of making the *oleum ſulphuris per campanam*, or converting almoſt the whole body of the ſulphur into acid ſpirit; with ſo much of the diſcoveries of M. *Homberg*, and Dr. *Stahl*, relating to the analyſis, regeneration, and production of this mineral, as tends to the ſervice of pharmacy.

XXXIII. Experiments to ſhew the manner of diſſolving ſulphur in fix'd or volatile alkalies, alcohol, and oils; whence the ſeveral balſams and tinctures of ſulphur, liver of ſulphur, and lac ſulphuris.

Purification of mineral ſalts. XXXIV. The beſt methods of procuring and purifying mineral ſalts, and fitting them for pharmaceutical uſes; particularly nitre, ſea-ſalt, alum, and vitriol.

XXXV. The various methods of refolving mineral falts into their acid fpirits, and rectifying them: or the ways of making oil of vitriol, fpirit of fea-falt, fpirit of alum, fpirit of nitre, and dulcifying them for pharmaceutical ufes. Add to thefe the compound acid fpirits, or the *aquæ fortes*, and *aquæ regiæ*, for pharmaceutical purpofes; with the methods of extracting new falts from the feveral refiduums, for the ufes of pharmacy; whence the *fedativum Hombergii*, *fal mirabile Glauberi*, a falt like the *Epfom*-falt, the *fal enixum Paracelfi*, the common *tartarus vitriolatus* of the fhops, the *arcanum duplicatum*, &c. *The mineral acids.*

XXXVI. Experiments to fhew the methods of purifying all the metals, and metalline matters, and fitting them for pharmaceutical ufes. *Metals and their calces.*

XXXVII. Experiments to fhew the beft ways of preparing the metalline tinctures, folutions and calces, with the fimple and mix'd mineral acids; whence the pharmaceutical folutions, fublimates, calces, vitriols, and crocus's of iron, lead, filver, tin, copper, mercury, and gold. *Metallic tinctures.*

XXXVIII. The pharmaceutical preparations of iron; *viz. crocus Martis aftringens & aperiens*; *oleum Martis per deliquium*; *tinctura Martis aurea*; *tinctura Martis cum vino & cum aceto*; *flores ammoniaci Martiales*, &c. *Preparations of iron.*

XXXIX. The pharmaceutical preparations of lead; *viz. faccharum Saturni*; the calx of lead, white-lead, yellow-lead, and red-lead, balfam of lead, and plaifter of lead. *Of lead.*

XL. The pharmaceutical preparations of filver; *viz.* the cryftals of filver, the filver pill, the precipitate and tincture of filver, the lunar cauftic, and the *Luna cornua*; with their reduction to filver again. Add hereto, the folution of filver, for turning red and grey hair into black or brown. *Of filver.*

XLI. The pharmaceutical preparations of tin. Calx of tin; amalgam of tin with mercury; falt of tin, magiftery of tin, flowers of tin, fublimate of tin, fmoking oil of tin, and *aurum Mofaicum*, as 'tis call'd. *Of tin.*

XLII. The pharmaceutical preparations of copper. The folutions of copper in various faline, or acid and alkaline menftruums; whence *aqua fapphirina*, and various vitriols. The preparation of verdigreafe; the fpirit of verdigreafe; the calx and crocus of copper; *æs uftum*; and Mr. *Boyle*'s *ens Veneris*. *Of copper.*

XLIII. The pharmaceutical preparations of quickfilver. The general method of amalgamating metals. The folutions and cryftallizations of quickfilver. The beft ways of making corrofive-fublimate, *Mercurius dulcis*, calomel, red precipitate, yellow precipitate, or *turpethum minerale*, white precipitate, and the oil of mercury: with the ways of making quickfilver into *Æthiops* mineral, cinnabar, and a faccharine powder. *Of quickfilver.*

XLIV. The pharmaceutical preparations of gold. The folutions of gold, the amalgam of gold, *aurum fulminans*, various calces of gold: with the more fuccefsful methods of making an *aurum potabile*, and fublimate of gold. *Of gold.*

XLV. The pharmaceutical preparations of antimony. The feparation of antimony into fulphur and regulus. The pure, fimple, and martial regulus of antimony: with a certain way of making the *regulus Martis ftellatus*. The beft ways of preparing *antimonium diaphoreticum*, *nitrum antimoniatum*, *antihecticum Poterij*, butter and oil of antimony, the *Mercurius vitæ*, *Bezoar* *Of antimony.*

mineral, and cinnabar of antimony. The emetic cups, perpetual pills, emetic flowers, and purging flowers of antimony; the *crocus metallorum*; and *tinctura metallorum*; the *Bezoardicum Solare, Lunare & Martiale*; the calx, ſublimate, and glaſs of antimony.

True and falſe method of preſcribing in pharmacy. XLVI. Experimental inſtances of the true and falſe manner of preſcribing, both in officinal and extemporaneous pharmacy; with relation to efficacy and elegance.

Sophiſtications. XLVII. A ſet of experiments to ſhew the more conſiderable adulterations, ſophiſtications, and ſubſtitutions practiſed among the trading chemiſts, wholeſale apothecaries and druggiſts; with the certain ways of diſtinguiſhing the *vera* from the *communia*. For example; the common ſophiſtications of the dear eſſential oils, as particularly oil of cinnamon, nutmeg, cloves, ſpike, *&c.* The rich balſams, as thoſe of *Peru*, *Tolu*, and *Gilead*, ſtorax, galbanum, *&c.* The roſins of jalap and ſcammony; ſalt of amber, ſalt of vipers, *Bezoar*, *Goa*-ſtone, *Gaſcoign*'s-powder and pearl; *oleum ſulphuris per campanam*, *antimonium diaphoreticum*, cinnabar native and factitious, quickſilver, *&c.*

The authors who have treated the ſubject of Pharmaceutical Chemiſtry *are numerous; the generality of Chemiſts having bent their ſtudies this way. Among the principal to be recommended for the ſervice of this courſe, come* Charas, Zwelfer, Dan. Ludovicus, Le Febure, Lemery, Wilſon, Staphorſt, Barchuſen, *the* Collectanea Chemica Leydenſia, *the* Pharmacopœia Collegij Regalis Medicorum Londinenſis, *and* Edenburgenſis; Boerhaave'*s* Chemiſtry, Quincy'*s* Diſpenſatory, *and* Hoffman'*s* Obſervationes Phyſico-Chymicæ.

IV.

Scheme for a Courſe of Metallurgical Chemiſtry; or, the Art of preparing Metals for Human Uſes.

The Metallurgia Vulgaris.

Foundation of metallurgy. I. THE general foundations of metallurgy, as it regards the diſcovery, ſinking, draining, and working of mines; with the manner of erecting the ſmelting-huts, and furnaces for ſeparating the metal from the ore, in the larger works.

Two original books for this purpoſe, are Agricola de Re Metallica, *and* Ercker'*s* Aula Subterranea.

Preparation of the ore. II. The previous chemical operations required to fit ores for the furnace; *viz.* roaſting, ſtamping, waſhing, and ſifting: with the beſt methods of diſpatching this buſineſs, ſuitably to the nature of the ore; or as it contains gold, ſilver, copper, or tin.

Beſides the Authors juſt mention'd, conſult upon this head, Dr. Stahl'*s* Metallurgiæ Pyrotechnicæ, & Docimaſiæ Metallicæ Fundamenta.

Aſſays of ores. III. The particular methods of taking proof, or making aſſays of all kinds of ores, before they are ſmelted; ſo as to diſcover what proportion of pure metal

metal they contain; with the way of reducing all metallic fubftances to a regulus: whence a practical introduction to the art of chemical minerology, and the ufe of fluxes.

See as to this head Georg. Agricola de Re Metallica, *and the Writers upon the* Art of Affaying.

IV. The particular methods of fmelting gold-fand, gold-ore, gold-fluds, and filver-ore, fo as to procure the largeft yield; with the ways of cafting the metal into ingots, bars, and blocks. *Smelting gold.*

See Agricola, Ercker, Glauber, Becher, *and* Stahl.

V. The methods of feparating tin, lead, bifmuth, antimony, *&c.* and cafting them into blocks, pigs, or folid cones; as practifed at the mine-works of *England*, *Germany* and *Hungary*: with the way of feparating and purifying quickfilver. *Tin, lead, bifmuth, &c.*

See the Authors above-mention'd; and the Philofophical Tranfactions.

VI. The common ways of running copper and iron from the ftone; and of refining them into foft, ductile metal, or forming them into plates and bars. The art of making the pureft copper, and tougheft iron, for the more curious ufes: with the beft ways of cafe-hardening iron, and turning it to the fineft fteel. *Copper and iron.*

To this purpofe confult Agricola, Ercker, Becher, Stahl, Reaumur, *and certain Papers in the* Philofophical Tranfactions.

VII. The methods in ufe for extracting gold and filver from the bafer metals, at the larger works of *Germany*, *Hungary*, and *England*. *Extracting gold, and filver.*

See Agricola, Ercker, Stahl, *and* Homberg, *who has a curious Paper in the* Memoirs of the Royal Academy, *that affords a hint for the improvement of this affair.*

VIII. The whole art of refining the nobler metals; as practis'd among the refiners of *London*. *Refining.*

Dr. Merret *has a Paper upon this Subject in the* Philofophical Tranfactions; *which may be compared with* Agricola'*s Defcription of the Art, at the clofe of his work* de Re Metallica.

IX. The art of affaying plate, coin, and ores; as practis'd among the goldfmiths and common refiners of *London*. *Affaying plate.*

See upon this head Agricola de Re Metallica, Ercker, *and* Olai Borrichij Docimaftice.

X. The feveral ways of coating or overlaying one metal with another; whence the art of gilding, filvering, tinning, and quick-filvering. *Gilding, tinning, &c.*

There are fome Papers upon this Subject in the Philofophical Tranfactions, and French Memoirs; *and the foundations of the thing are delivered by* Barchufen, *towards the Clofe of his* Pyrotechnia, *or* Elementa Chemiæ.

XI. The art of foldering in the different kinds of metals; with the manner of preparing all forts of folders for the ufes of tin-men, brafiers, copper-fmiths, pewterers, filver-fmiths, and gold-fmiths. *Solders.*

Some few hints to this purpofe may be found in Mr. Boyle'*s* Philofophical Pieces, *and* Barchufen'*s* Pyrotechnia.

XII.

Electrums. XII. The art of mixing metals and metalline ſubſtances, ſo as to form compound metals, electrums, braſs or latton, cannon-metal, pin-metal, white-metal, *Bath*-metal, and all the mix'd metals in uſe.

For hints to this purpoſe ſee Houghton's *Letters, the* Philoſophical Tranſactions, Barchuſen, *and* Stahl.

Wire. XIII. The art of wire-drawing, or forming metals into wire, of various ſizes for various uſes; with the different manners of gilding it.

To this purpoſe there are ſome hints in Mr. Boyle's Philoſophical Works, *and the* Philoſophical Tranſactions.

Tinging metals. XIV. The art of colouring the whole ſubſtance of metals, ſo as to make white copper, white gold, yellow ſilver, *&c.* with the certain ways of detecting impoſitions of this kind.

See Boyle, Becher, Barchuſen, Boerhaave, *and* Stahl.

Amalgams and vitriols. XV. The ways of diſſolving all metals with ſuitable menſtruums, or reducing them to vitriols, and amalgams, for particular metallurgical uſes.

See Hollandus, Becher, Homberg, Stahl, *and the common books of chemiſtry.*

Vitrification of metals. XVI. The ways of converting metals into glaſs; particularly lead and antimony, for the buſineſs of aſſaying and teſting of ſilver and gold, and the making of powerful fluxes for ſtubborn ores.

See Agricola, Ercker, Becher, Stahl, Borrichius, *and the common chemical Writers.*

Caſting. XVII. The more curious experiments in the art of foundery or caſting of metals; particularly the way of caſting in iron, ſo as to make works as beautiful as in hammer'd iron.

M. Reaumur *has publiſh'd a book upon this ſubject; an account whereof is given in the* French Memoirs.

Smithery. XVIII. The more curious metallurgical experiments in the art of ſmithery, extracted from the practices of gold-ſmiths, ſilver-ſmiths, braſiers, copper-ſmiths, tin-men, pewterers, iron-ſmiths, gun-ſmiths, lock-ſmiths, *&c.*

Some particulars to this purpoſe may be found in the French *and* German *Writers upon the arts of* foundery *and* ſmithery; *Mr.* Boyle's *Works and the* Philoſophical Tranſactions.

Particular extractions. XIX. An attempt to introduce certain curious, or more conceal'd proceſſes of metallurgical chemiſtry into the vulgar art of metals: as the method of extracting ſilver from tin; gold from ſilver; gold from ſand, *&c.*

See upon this head Glauber, Becher, Boyle, *and* Stahl.

Mineræ perpetuæ. XX. An experimental inquiry into the validity of *Becher*'s *Minera perpetua*, or the art of procuring gold and ſilver, with moderate profit, from common mineral, or cheap metalline matters.

Dr. Stahl *has a paper to this purpoſe, entitled* de Metallorum Emendatione, modico fructu, profutura; *which may ſerve to regulate the conceptions of* Glauber *and other* Chemiſts *upon the ſame ſubject.*

Beſides the few Authors already indicated, conſult certain Pieces of Paracelſus, Glauber, *and* Kunckel; Webſter's *Book of* Metals, Alonſo Barba, *Dr.* Liſter, *and Dr.* Woodward.

A Scheme

V.

A Scheme for certain Courſes of the Chemia Curioſa : *or, Sets of ſuch chemical experiments as are more entertaining than profitable; yet ſuited to the improvement of Philoſophy and Arts.*

(I.)

Certain curious chemical experiments relating to natural philoſophy.

I. TO ſhew the chemical nature, generation, production, changes and deſtruction of light, fire, flame and fewel; by means of the various kinds of phoſphorus, and *Hoffman*'s phlogiſtic liquor: with a particular inquiry into *Stahl*'s phlogiſtic, and *Homberg*'s ſulphureous principle. *Nature of light, fire, and fewel.*

See Boyle, Homberg, *and the younger* Lemery *upon the ſubject of phoſphori*; Boerhaave *and* Newton, *upon the nature of light, flame, fire, &c.* Homberg's *eſſays upon the chemical principles, and* Stahl's *ſeveral pieces in metallics.*

II. The chemical generation, changes, and deſtruction of cold and heat; illuſtrated in a variety of experiments. *Changes of cold and heat.*

To this purpoſe ſee the experiments of the Lord Bacon, *Mr.* Boyle's Hiſtory of Cold, *and the accounts of certain cold fermentations and effervеſcences in the* French *Memoirs, by M.* Homberg *and others.*

III. The chemical generation, changes, and deſtruction of colours, exemplified by a ſet of curious experiments. *Colours.*

See Boyle *on colours,* Newton's *optics, and certain papers in the Philoſophical Tranſactions, and* French *Memoirs.*

(II.)

Uncommon experiments relating to animal arts.

IV. Attempts to preſerve animal fleſh ſweet, without ſalt, in long ſea-voyages. *Fleſh preſerved.*

See Glauber, Boyle, *and thoſe who have wrote the natural hiſtory of ſugar.*

V. Attempts to introduce certain new colours into the arts of dying and callico-printing; particularly a permanent blue, capable of being impreſs'd or laid on without dipping. *New colours for dying, &c.*

See Blancour's *art of glaſs* ad finem; *and the travels of Naturaliſts who give any accounts of the* Indian *pigments and colours.*

VI. Attempts to improve the art of embalming; particularly by the uſe of the amber varniſh, ſo as to coat over a human body with amber. *Embalming.*

See Boyle, Boerhaave, *and* Hoffman.

VII. Attempts to introduce certain new matters for anatomical injections, that ſhall ſhew the parts in their natural ſtate. *New anatomical injections.*

For hints to this purpoſe ſee the anatomical works of Ruyſch; *and* Homberg's *paper upon the ſubject.*

(III.)

(III.)

Experiments relating to vegetable arts.

Wines improved. VIII. Attempts to imitate the wines of the firſt growths of *France*, and of the *Rhine*; and the richeſt wines of *Italy*, *Hungary* and *Greece*.

See certain papers in the German Ephemerides *upon this ſubject*; *and compare them with the doctrine and experiments of* Glauber, Becher, *and* Stahl, *made with the ſame view.*

IX. Attempts to produce ſound wines, vinegars, and tartar, from the vegetable juices of *England*; and diſtilling theſe juices into brandies of equal goodneſs with thoſe of *France*, *Goa*, or *Batavia*.

See this ſubject conſidered by Glauber, *with regard to* Germany; *and improv'd by* Becher *and* Boyle.

Teas imitated. X. Attempts to imitate or exceed the teas of *India*, the coffee of the *Levant*, and the chocolate of the *Iſles*, by means of commodities of *Engliſh* growth.

To this purpoſe conſult certain papers in the German Ephemerides.

(IV.)

Experiments relating to the *Metallurgia Sublimior*.

Mercuries of metals. XI. The mo e rational attempts to reduce all the metals to their running mercuries, or extracting a proportion of mercury from them.

See Baſil Valentine, Paracelſus, Boyle, Becher, Homberg, *and* Stahl.

Butter of metals. XII. The converſion of metals into a butyraceous or waxy ſubſtance.

See Hollandus de Salibus & Oleis Metallorum, *and* Homberg's *paper as to a certain matter running thro' the ſolid body of metals, like water thro' a ſieve.*

Whether tranſmutation be poſſible. XIII. Experimental attempts to convert mercury into metal, iron into copper, and ſilver into gold; with an account of the fallacies and groſs impoſitions diſcovered in this affair.

(V.)

Uncommon Experiments relating to the mineral arts,

Varniſh and china. XIV. Attempts to prepare varniſhes and porcellane-ware, exceeding thoſe of *China* or *Japan*.

See certain papers in the philoſophical tranſactions, French Memoirs, *and* German Ephemerides.

Fine copper. XV. Attempts to imitate tutenag, the white and red copper of *Japan*, and the fineſt bar-copper of *Germany*.

See Dr. Woodward, Stahl, Homberg, *and the profeſs'd metallurgiſts.*

XVI.

XVI. The moſt promiſing methods of making malleable iron with pit-coal, in the large way. *Malleable iron with pit-coal.*

See Dr. Stahl, *in his ſeveral curious pieces upon iron.*

XVII. Attempts to make regulus of antimony malleable. *Regulus of antimony ſoftned.*

See Becher *and* Stahl *upon the lead of antimony*; *and compare them with* Boerhaave'*s doctrine as to the reduction of antimony to ſilver.*

(VI.)

Chemical experiments relating to pharmacy and medicine.

XVIII. Attempts to imitate the more celebrated mineral waters of *Germany* and *England*; as thoſe of *Pyrmont*, and *Bath*, *&c.* from an exact chemical analyſis thereof. *Imitation of mineral waters.*

See Mr. Boyle, *Dr.* Hoffman, *and various papers of the* French *memoirs.*

XIX. Attempts to imitate certain foreign drugs; as opium, camphire, balm of *Gilead*, oriental bezoar, nitre, ſal-ammoniac, borax, *&c.* *Of drugs.*

See Pomet'*s hiſtory of drugs, and* Savary'*s dictionary.*

XX. Attempts to imitate or excel the vegetable eſſences, perfumes, and fucus's of *Italy* and *Spain.* *Of eſſences.*

See Paracelſus, Glauber, Boerhaave, Pomet, *and* Stahl.

(VII.)

Uncommon experiments relating to mix'd arts.

XXI. Experiments relating to the chemical production, alteration, deſtruction, and regeneration of colours, ſtains and inks; in cloths, ſilks, cottons and papers. *Inks.*

See Mr. Boyle, *Dr.* Merret, *and M.* Homberg.

XXII. Ways of making certain pernicious mixtures, capable of producing devaſtations. *Pernicious mixtures.*

See Lemery'*s paper upon earthquakes, lightning,* &c. *in the* French *memoirs. See alſo* Boerhaave'*s chemiſtry*; *and Dr.* Hoffman'*s obſervations.*

XXIII. Experiments relating to the more perfect ways of annealing and ſtaining in glaſs. *Staining glaſs.*

See Neri, Kunckel, Blancour, *the author of* Sol ſine veſte, Becher, *and* Stahl.

XXIV. Attempts to convert all the metals into their ſpecific glaſſes, without addition. *All the metals vitrifiable.*

See M. Homberg'*s chemical experiments with the great burning lens*; *and compare them with the operations of* Neri *and* Kunckel *at a glaſs-houſe fire.*

XXV. Attempts to ſoften glaſs, or bring it towards a malleable ſtate: and again, for giving it nearly the hardneſs of a diamond. *Glaſs made ſofter and harder.*

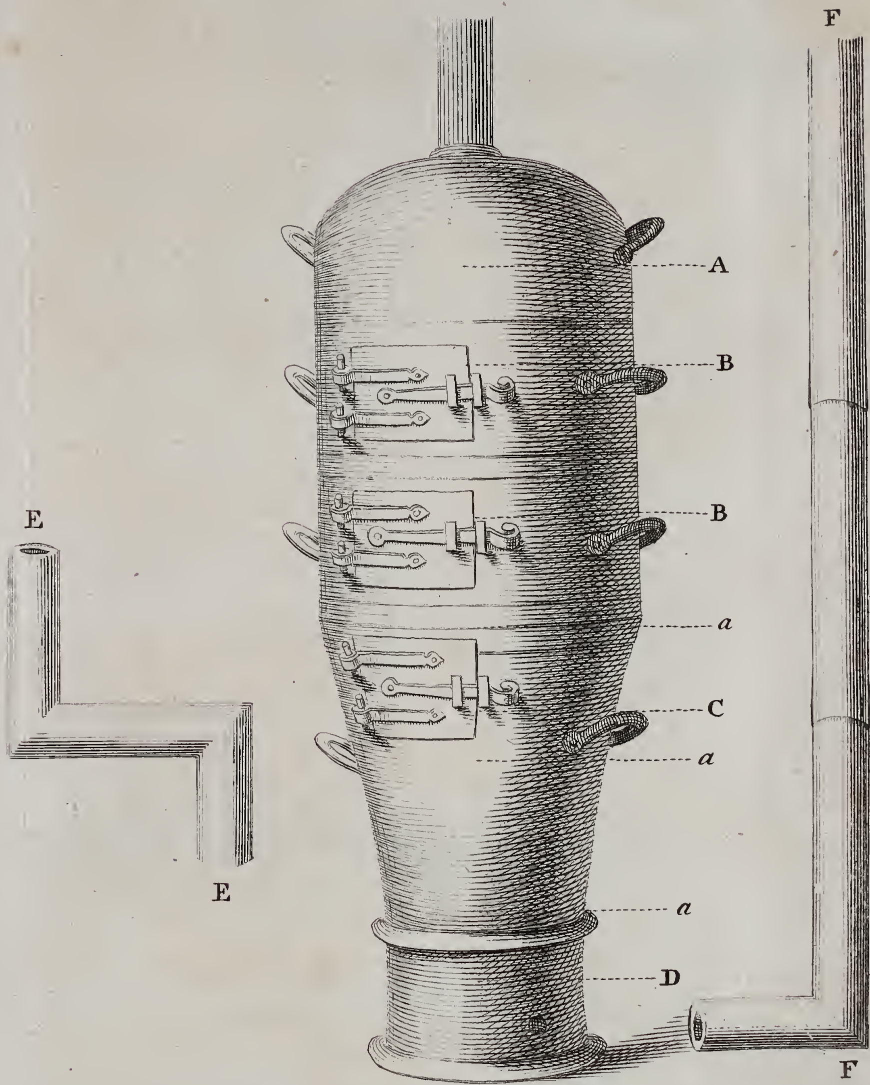
See Boyle *and* Homberg *upon this curious ſubject*; *and compare them with* Neri, Merret, Blancour, *and* Kunckel.

One might proceed to ſketch out ſchemes for courſes of recreative chemiſtry; ſhewing the artificial generation of meteors, new ways of illuminating roads and ſtreets, making new kinds of fire-works, and exhibiting numerous other productions and phænomena of this art, in the way of what was antiently term'd natural magic: but thus much may ſuffice, for the preſent, to ſhew that the art has hitherto been too much confin'd, and deſerves to be ſet free, or cultivated at large, for the advantage of mankind.

F I N I S.

THE

Plate I.



An external View of the Furnace when all its parts are out of use

A the Cover with its upright Funnel D. The close Foot

B.B. The two Rings aaa. The Places of the three Grates

C. The Body E.E. The Top Elbow Funnel

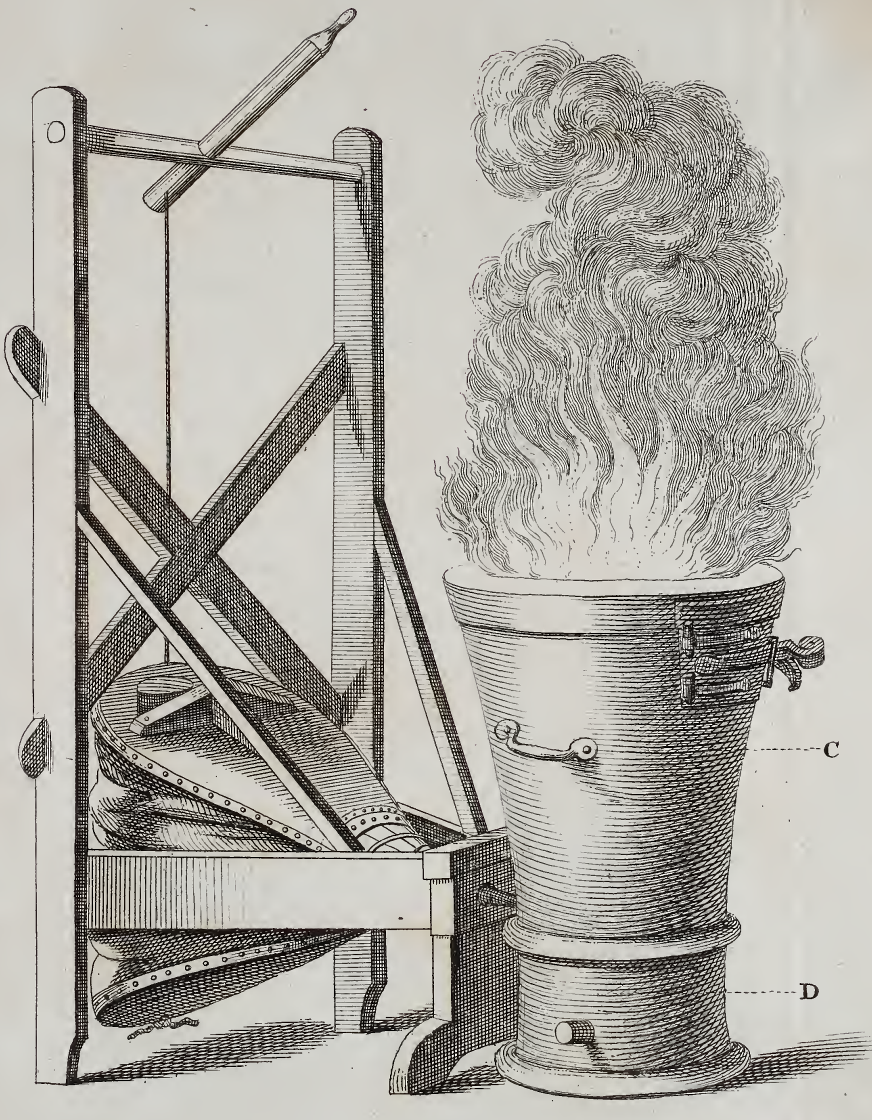
J Vander Gucht Sculp. F.F. The Lateral Funnel

Plate II.

An internal View of the Separate Parts of the Furnace.

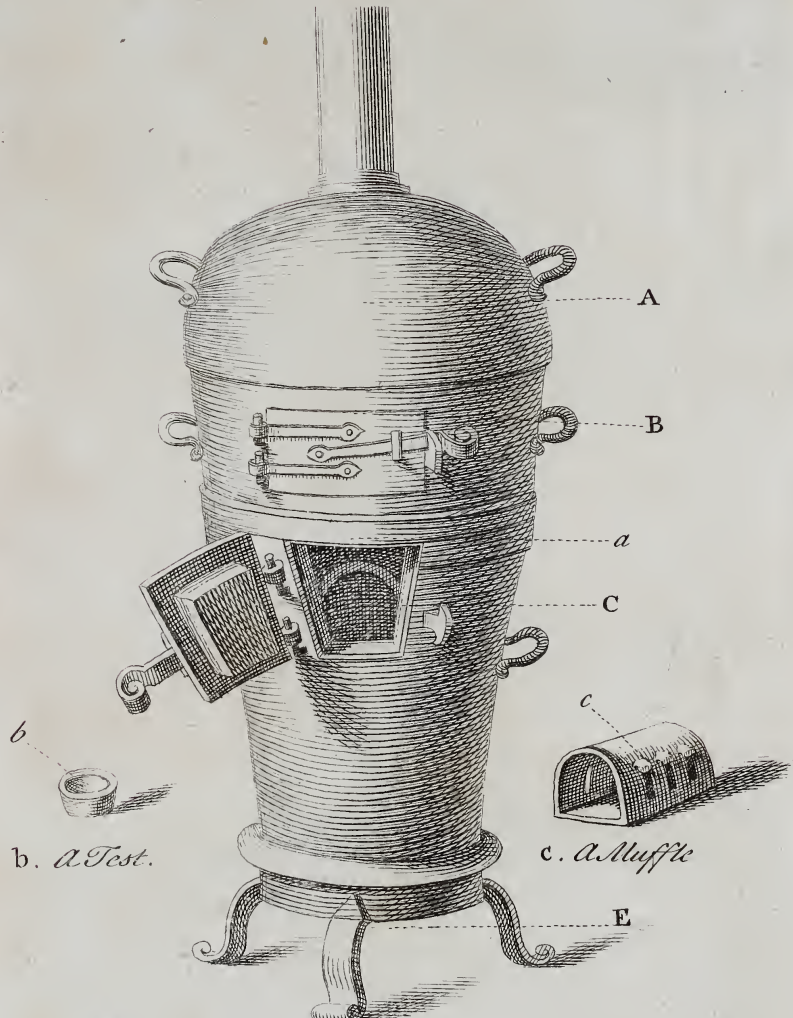
J. Vander Gucht Scul.

Plate III.



A Smelting Furnace at Work, compos'd only of the Body and close Foot, C, and D, without a Grate.

J Vander Gucht Sculp.



A Testing Furnace, preparing for the Operation; and consisting of the Cover A. *with its upright Funnel; the Ring* B; *the top Grate placed at* a; *the Body,* C, *and the open Foot,* E

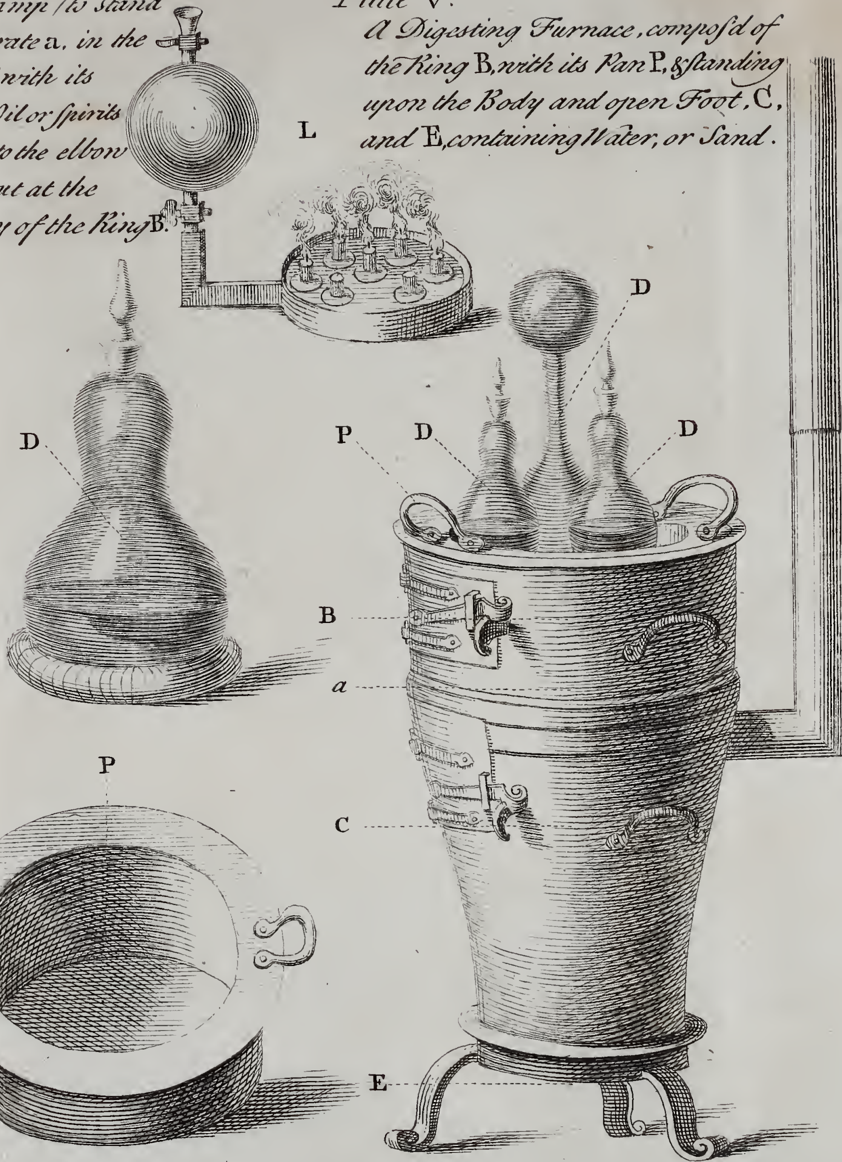
J Vander Gucht Sculp.

Appendix.

Plate V.

A Digesting Furnace, compos'd of the Ring B, *with its Pan* P, *& standing upon the Body and open Foot*, C, *and* E, *containing Water, or Sand.*

L. *A Lamp (to stand on the Grate* a. *in the Ring* B.) *with its Ball, of Oil or spirits fitted on to the elbow coming out at the door-way of the Ring* B.



D D D D *are digesting Glasses, and* P P *the Pan for making a Balneum Mariæ, or Sand Heat.*

J Vander Gucht Scul.

Plate VI.

A Hot Still at work where the common Cover is changed for a Pewter Still-Head A; and the Vesica or Copper Vessel, U, goes into the hollow Ring, B; the middle Grate being placed at a in the Body C standing upon the open Foot E.

X the Refrigeratory containing its Pewter-Worm.

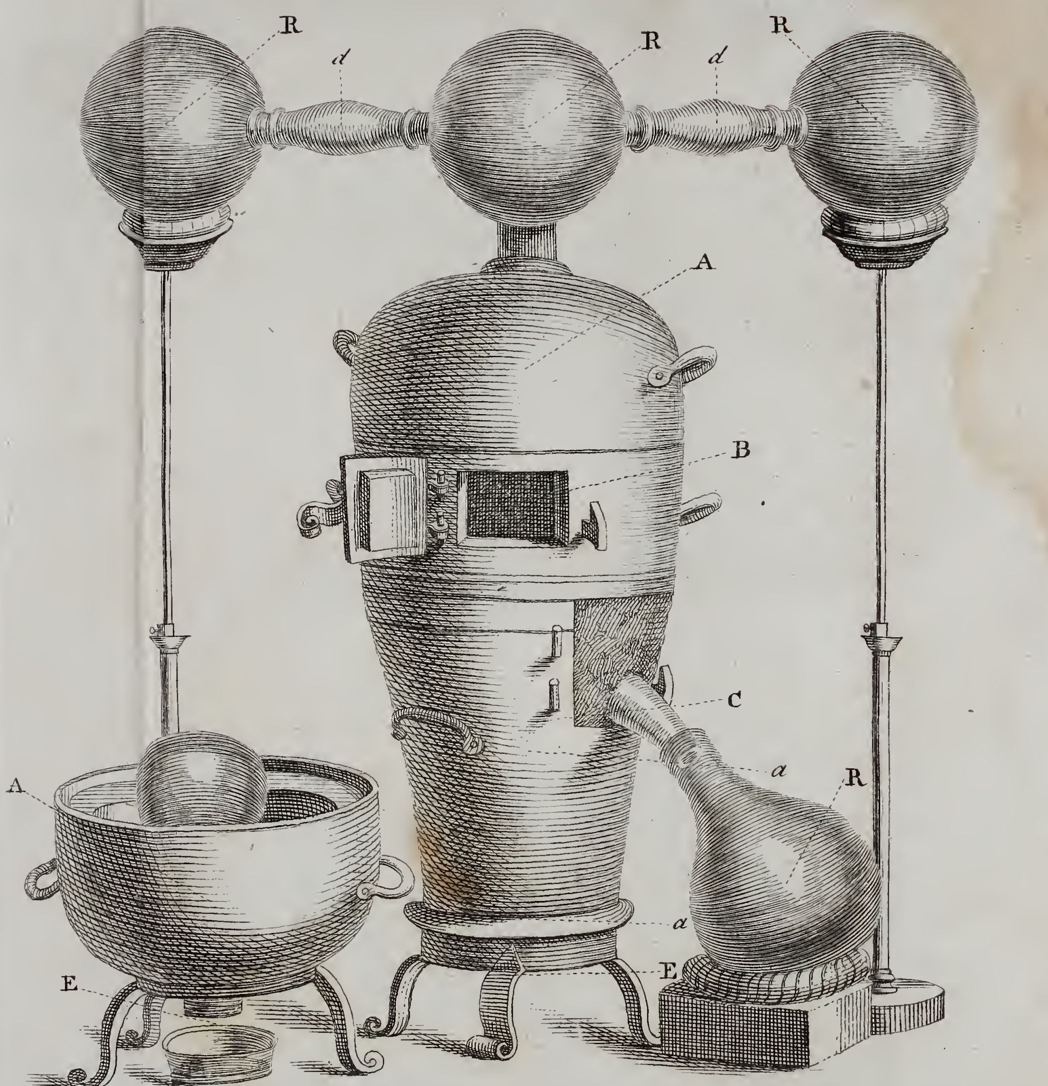
J. Vander Gucht Sculp

Appendix.

Plate VII.

J Vander Gucht Scul.

Plate VIII.



A Furnace for Sublimation and Distillation by a naked Fire, with a Set of Receivers RRRR, *and Adopters* dd. *The Fire being either upon the lower or the middle Grate* aa, *the Matter may be thrown in at the Door of the Ring* B; *the whole Furnace supplying the place of a distilling or subliming Vessel When the Fire is upon the lowest Grate,* a, *the Neck of the distilling Vessel comes out at the Door of the Body* C, *standing on the open Foot,* E,

J Vander Gucht Sc. *When the Cover,* A, *is inverted into the open Foot* E *it makes a commodious Furnace for distilling per descensum: as express'd in the Side-Figure* A E.

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N. B. *The letter* p. *refers to the Practice, or third part of the book; and the letter* n. *to the Notes.*

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